BRAI

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MATABELELAND.

SCATTERED through the states that lie on the further side of the Rocky Mountains there are to be found, even to-day, survivors of the early Indian massacres, to whom the present uprising of the native races in South-eastern Africa will prove a reminder of many a heart-rending scene of rapine and massacre. Deplorable as such bloody revolts may be, they seem to be inseparable from the early history of the subjugation of savagery by civilization; and, looked at from the standpoint of the native owners of the soil, such uprisings are right and patriotic. The methods of warfare adopted by a savage or even a semicivilized race in its attempt to wipe out the invader may seem brutal enough to us, upon whose mind has shone the light of a thousand years of civilization; and we are apt to forget that when the savage starts in on a wholesale butchery such as is now being wrought upon the settlers of Rhodesia, he is merely acting up to the tradition of his ancestors, and writing his declaration of independence in letters of fire and blood.

Matabeleland forms a part of an enormous stretch of territory which is commonly known as Zambesia; though the South Africans prefer to call it Rhodesia, in honor of Cecil Rhodes, the late premier of Cape Colony, who was mainly instrumental in bringing it within British control. Matabeleland, which is bounded by Bechuanaland on the south and Mashonaland on the northeast, has an area of about 125,000 square miles, and its native population is estimated at about 200,000. The country was originally occupied by native tribes known as the Mashonoas and the Malakas; but some fifty years ago King Moselekapse, with a powerful Matabele army, entered the country, subdued it, and set up a powerful military despotism. He maintained a standing army of 15,000 well drilled and well equipped soldiers, which was divided into kraals and commanded by Indunas. The king was an absolute monarch, and the Mashonoas and Makalas were obliged to pay tribute to him.

In 1889 a royal charter was granted to the British South African Company, "conferring on it large powers of administration, so as to enable it to extend northward the railway and telegraph systems of Cape Colony and Bechuanaland." The telegraph was extended into Matabeleland, and a road was cut through into Mashonaland. The repeated raids of the Matabeles under King Lobenguela upon the Mashonas led Dr. Jameson, the administrator of the company, to organize an expedition which advanced against Buluwayo, the chief kraal of the Matabeles, and broke the power of the king. The lesser chiefs submitted to Jameson, and an agreement was made between the British South African Company and Her Majesty's government for the settlement of the country. It was placed under an administrator appointed by the company, with the approval of the Secretary of State, for a term of three years. A land commission was appointed to deal with all questions of native settlements in Matabeleland, the company retaining the mineral rights in all lands which were given to the natives. The instructions were that the commission should assign to the natives "land sufficient and suitable for their agricultural and grazing requirements, and cattle sufficient for their needs." This was done, and in such a way that the natives, who expressed themselves as well pleased with the distribution, gave up their arms, and settled down to plowing and sowing for the harvest. The settling up of the country proceeded so rapidly that by the end of January, 1894, over 100,000 acres of farms had been staked out by intending settlers, and gold claims were rapidly being taken up. According to Mr. P. Lemosof, however, who writes in Magasin Pittoresque, the development of the country is not immediately promising or profitable. He says: "The results thus far obtained by no means correspond to the amount of money and labor expended in the exploitation of the country; for, although some parts of the territory, in the neighborhood of the rivers—like that in the neighborhood of Senna shown in our engraving—present a real tropical beauty, the greater part of Zambezi is arid and barren, its only riches being a few auriferous veins which scarcely repay the cost of the first installation; and furthermore, it is very difficult to establish trade with the natives, especially with the Matabeles, who are supposed to belong to the most refined tribe of the Kafir races. Imperious, warlike, accustomed to maintain themselves by their raids on neighboring tribes, Matabeleland was, until a few years ago, a very powerful realm. The chiefs of all of these South African tribes, the Mashonas, the Matabeles and the Zulus, enjoy a real authority in spite of their air of indifference and physiognomies which offer so little that is attractive in the eyes of white men, and for this authority there is fierce contention among the descendants of a deceased chief.

Like the ancient feudal lords, African princes usually obtain supremacy over their people only at the price of the blood of their opponents. The reign of

A MATABELE KRAAL.

THE CHARTERED COMPANY'S FORCES PRACTICING WITH THE MACHINE GUN.

HUT OF A HUNTER-TRADER IN MATABELELAND.

KING KHAMA'S RESIDENCE IN BECHUANALAND.

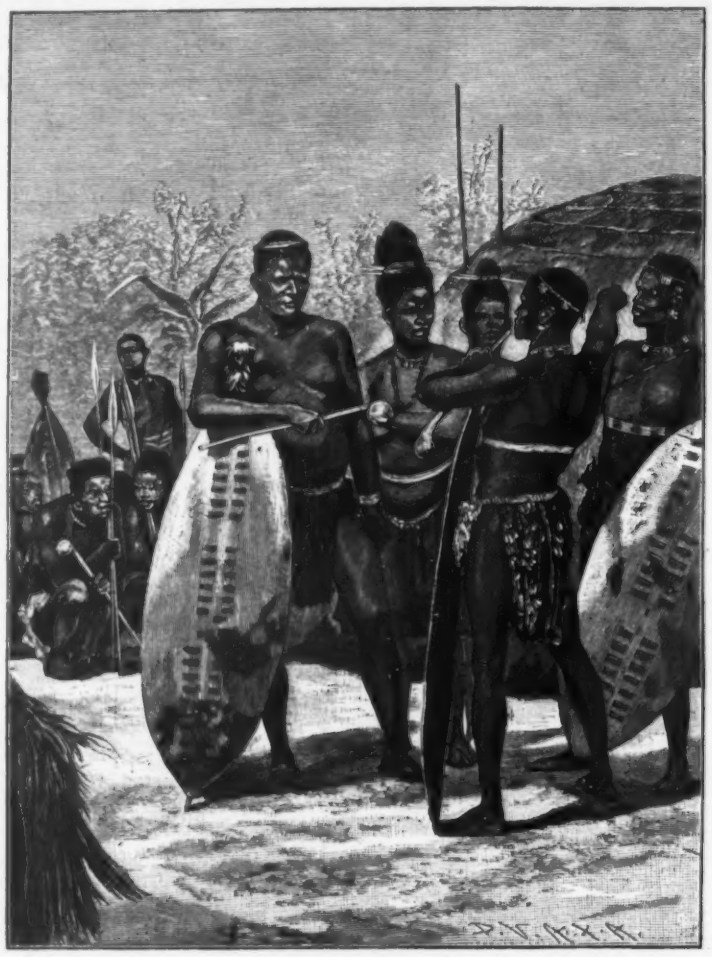
the last monarch of the Matabeles, Lobenguela, was inaugurated by the massacre of all of his brothers. It is true that he was encouraged in this particularly by his sister Njina, who hoped also to gain power, but having, in her turn, been accused of casting a spell over the queen, rendering her barren, the tender sister was condemned to death and hung from a tree on April 2, 1880. It is thus seen that the women of these countries play a certain part, in spite of the state of servitude endured by the "weaker" sex among all primitive races. The distribution of work is often quite the reverse of that which we are accustomed to see among civilized people. On the shores of the Zambezi, especially where the breeding and raising of cattle is impossible on account of the ravages of the fly tze-tze, agriculture constitutes the only occupation of the inhabitants. The work of the fields falls entirely upon the women, who start off early in the mornings to cultivate the ground and raise the grain and corn. Millet or sorghum, called mabele by the Matabeles and imphi by the other tribes, constitutes their principal food. The cooking is carefully attended to by the men who remain in the village, and they also take care of the household arrangements. After the return home the members of the family assemble around the pot, into which each one dips his five fingers and makes a ball, which quickly disappears down his throat. This is the one meal of the day. They talk often until very late at night, all smoking the daga, a kind of native tobacco, after which all go to bed, either inside of the huts or in the open air, rolled in a sheepskin.

Contrary to the practice among other African races, the Matabele women are subjected to a most austere regime, such as is almost unknown among other primitive peoples. Any immorality, especially of young girls, is severely punished, and European travelers have seen young people instantly put to death for such offenses. This severity is much relaxed in regard to their relations with whites, the birth of a halfbreed child giving prestige to the mother.

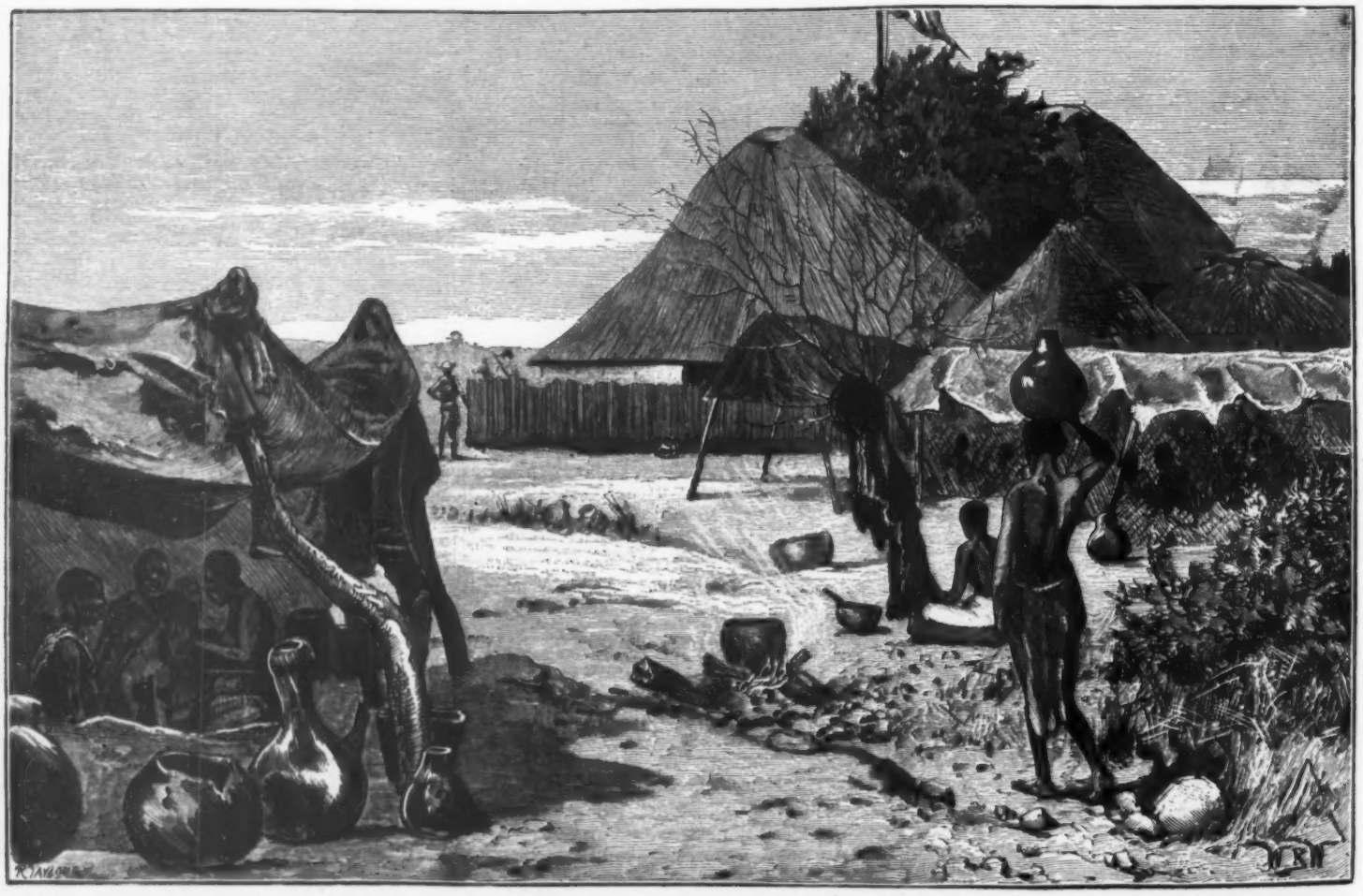
The dwellings of the Matabeles, as well as those of the Mashonas and other Kafir races of Southern Africa, vary according to the importance of the tribes and the positions of the occupants. Those intended for the masters are generally round, spacious, with an opening serving for a door by which admittance is obtained to the kraal or inclosure reserved for the members of the family. All are made of reeds or bamboo. Some of the tribes give a certain elegance to the construction of their houses, which are square and thatched, recalling the isbas of the Russian peasants. The huts occupied by the servants and slaves are, on the other hand, nothing but miserable kennels, often much dilapidated, and for a door there is only a hole at the base of the hut, which can be entered only by crawling in.

A slow transformation, however, is taking place in the lives of these people, as European civilization penetrates into their country. The Chartered Company, often decried, has already accomplished considerable work: roads have been made, railroads built and exchanges established where the natives become familiar with European products, the need of which they begin to feel more and more. Who knows but these grown-up children, gay, unconscious, naive rather than perverse, may render a great service to humanity by trying to fertilize the immense tracts which are still uncultivated and which can be transformed into productive land only by the labor of man?"

The causes of the present disturbed condition of Matabele land are not far to seek. There is no doubt but that the ill-advised raid of Dr. Jameson into the neighboring Transvaal country, and his defeat at the hands of the Boers, served to arouse the slumbering warlike spirit of the Matabele warriors, many of whom had turned from war to agriculture, prompted more by the force of circumstances than by any natural love for the tilling of the soil. To this must be added the terrible scourge, known as the "rinderpest," which is now sweeping through Southeastern Africa, and threatens to wipe out those herds of cattle which constitute the chief source of income of the African "rancher," as he would be called in Western America. As long as the Matabele natives saw their flocks increasing under the sway of a people who dealt out evenhanded justice, and furnished at once security to the farmer and means of transportation to a market where he could dispose of his products, he was content; but the unhappy conjunction of the Jameson escapade and the rinderpest scourge have awakened a spirit of restlessness in the half tamed Matabele, which only needed the inflammatory promptings of their priests and holy men to fan it into the flame of active rebellion. Thus far the efforts of the Chartered Company to suppress the



MATABELE CHIEFS HOLDING A WAR COUNCIL.



TEMPORARY LAAGER IN FRONT OF BULUWAYO, MATABELELAND.

rising have proved quite ineffectual. With 1,300 men in the company's service, or nearly three times as many as Dr. Jameson commanded when he overthrew Lobenguela, the outbreak should have been suppressed at once; but Jameson was on trial at Bow Street Police Court in London, for his incursion into a friendly state,

A SOUTH AFRICAN PRINCE.

and Cecil Rhodes was ill of fever on the frontier. The 1,300 men, however, failed to provide security for the white settlers, who were widely scattered throughout the territory, and in the first days of the rising, many a score of unfortunates were massacred. Men, women, and children fled to the shelter of the forts, or southward to Bechuanaland; and for the past few weeks the country has been practically in the hands of the Matabeles, the Chartered Company's forces holding the fortified posts, and making occasional demonstrations, which have been generally successful, against any gathering in force which the enemy might make. At the present writing it looks as though Matabeleland would have to be reconquered, and by a stronger force of white men than any that has yet entered the country.

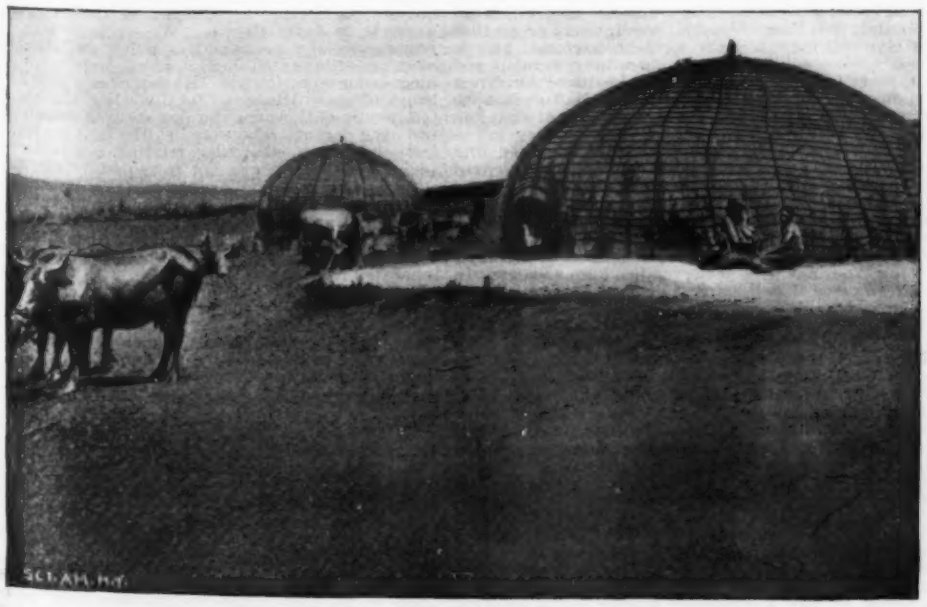
The terrible cattle plague which is devastating the country is said to be due to a vegetable parasite, which multiplies with incredible rapidity. This is not the first time that Africa has been subject to its ravages; for the French explorer Monteil, writing from the Soudan during his travels in Northern Africa, said that for a stretch of 500 miles he found that not one head of cattle in a thousand had escaped the plague. Captain Lugard has described the havoc wrought by the same disease in the neighborhood of Victoria Nyanza, and he is convinced that the present scourge in the south is the same that smote the district further north some years ago.

A NATIVE MEAL.

And thus it will be seen that, what with massacre on the one hand and plague on the other, the outlook for the newly acquired possessions of the Chartered Company is not a cheerful one. Nevertheless, no one who has watched the inevitable triumphs of civilization over barbarism in the past can doubt that, in spite of this temporary check, a transformation is taking place in the country and the people, which will be none the less sure because it is slow. Railroads and telegraphs cannot penetrate a country like this without bringing the blessings of civilization in their train; and the native tribes, despite their present outbreak, have shown themselves to be more readily amenable to the refinements of civilization that is usual among the primitive races of Africa.

We are indebted to the courtesy of Black and White, Illustrirte Zeitung, and Magasin Pittoresque for our illustrations.

A HUT IN PROCESS OF CONSTRUCTION.



MATABELE HAMLET.

NOTES ON CLOUDS.*

THERE are two points connected with clouds on which I wish to make a few remarks. The first is on the classification of clouds, and the second on the manner in which certain forms of clouds are produced. It may be as well to remark at the outset that the observations are those of an "outsider," being in a department of meteorology to which I have given but little attention, and they have been written with a view of calling the attention of specialists, and getting their opinion on the subject.

It appears to me that in classifying clouds they ought first of all to be divided into two great classes. In the one class should be placed all clouds in the process of formation, and in the other those in the process of decay. The two classes might be called clouds in formation and clouds in decay. We may take cumulus clouds as an example of the former, and nimbus of the latter. My observations made on the clouds themselves have shown that there is a difference in the structure of these two classes of clouds. In clouds in formation the water particles are much smaller and far more numerous than in clouds in decay; and while the particles in clouds in decay are large enough to be seen with the unaided eye when they fall on a properly lighted micrometer, they are so small in clouds in formation that, if the condensation is taking place rapidly, the particles cannot be seen without the aid of a lens of considerable magnifying power. In the former case the number of particles falling per square millimeter is small, while in the latter they are so numerous that it is impossible to count them.

It appears that one good end might be served by adopting this classification. It would direct the attention of observers more to looking on the processes going on in decay for an explanation of many of the forms observed in clouds. In most books on clouds, when describing the different shapes of clouds, it is almost always assumed that they are in process of formation and the whole explanation of the shapes taken by the clouds is founded on this supposition. Now it is very evident that very many clouds are in the process of decay, and their forms can only be explained by the processes going on under these conditions.

This brings me to the second point in this communication, namely, the manner in which ripple-marked cirrus clouds are produced. The explanation which has generally been accepted of the formation of this form of cloud is that the ripple markings are due to the general movements of the air giving rise to a series of eddies, the axis of the eddies being horizontal, and roughly parallel to each other. It is very evident that the air revolving round these horizontal axes, that is, in a vertical plane, will at the lower part of its path be subjected to compression, and at the upper part to expansion. The result of this will evidently be, supposing the air to be nearly saturated with moisture, a tendency for cloudy condensation to take place in the air at the upper part of its path, and it is this cloudy condensation in the upper part of the eddies that is supposed to produce the ripple-like cirrus; each ripple mark indicating the upper part of an eddy. One objection I have always felt to this explanation is, that it is difficult to imagine that the small amount of elevation and consequent expansion and cooling could give rise to so dense an amount of clouding as is generally observed. Any clouding produced in this way one would expect to be extremely thin and filmy. I have for the last few years made frequent observations of these clouds, and I have to admit I have never once seen them in the process of formation, or seen one appear in a clear sky. In all cases that have come under my observation, these ripple clouds have been clouds in decay. They are generally formed out of some strato-cirrus or similar cloud. When we observe these strato-cirrus clouds in fine weather, it will be found that they frequently change to ripple-marked cirrus clouds before vanishing. The process of their formation would seem to be: the strato-cirrus gradually thins away till it attains such a depth, that if there are any eddies at its level, the eddies break the stratus cloud up into parallel or nearly parallel masses, the clear air being drawn in between the eddies. It will be observed that this explanation requires the eddies, but not to produce the clouding, only to explain the breaking up of the uniform cirrus cloud into ripple cirrus.

One thing which supports this explanation is, that lenticular cirrus clouds are frequently observed with ripple markings on one or more sides of them just where the cloud is thin enough to be broken through by the eddies. If we watch these lenticular formed clouds under these conditions, we frequently see the ripple markings getting nearer and nearer the center as the cloud decays; and at last, when nearly dissolved, the ripple markings will be seen extending quite across the cloud. It seems probable that "mackerel" and other cloud forms may be produced in the same way.

The shapes which these ripple cirrus clouds assume are much more varied than is generally supposed. I lately observed a most interesting form in the south of France while the mistral was blowing strongly. There were a few cirrus clouds in the sky at the time, and one of these was rapidly being broken up into irregular ripple forms, but at one point there was formed a most perfectly cylindrical-shaped piece, its length being about twenty times its diameter. The whirling effect of the eddy was very evident by the circular streaking of the clouding. Further, this cloud was evidently hollow, that is, the interior was filled with clear air, as the cloud was thinnest along the axis, and it had all the appearance of a revolving tube of cloudy air.

It is not contended here that ripple clouds are never produced in the manner which has generally been accepted, only that so far as my observations go they have never been observed forming in the manner supposed.

* Paper read by John Aitken, F.R.S., to the Roy. Soc. of Edin. on May 4.—From Nature.

It is hoped that others will put the explanation here offered to the test of observation, and it is principally with a view of getting others to repeat the observations that this has been written.

THE HEREDITARY TRANSMISSION OF MICRO-ORGANISMS.

IT is well known that in the construction of many of the theories of heredity the doctrine of the transmission of acquired characters has obtained considerable prominence. The hypothesis of Lamarck rendered it necessary to assume that structural characters which had arisen from the use or disuse of organs, became an integral part of the individual and reappeared in the descendants, and although the application of this idea became greatly restricted when the principle of natural selection was established, it is only within the last few years that the transmission of acquired characters has been considered as unproved, and the instances put forward in support of this view to be capable of a different explanation. It may be admitted that mutilations and permanent injuries can be included among acquired characters, and the structural and functional modifications of the individual which occur in disease may persist, and, therefore, also be considered as definite morphological or physiological changes. Mutilations apparently do not pass from parent to offspring, and this has been especially pointed out by Weismann and his followers, since, if heredity is capable of explanation on the hypothesis of the continuity of germ plasm contained in definite reproductive cells, any change in the structure or modes of activity of the essential body or somatic cells would not be transmitted. An identical line of argument also negatives the belief that diseases can be inherited, and this view was maintained by Weismann in his well-known criticism on the transmission of experimental epilepsy; the symptoms in this hereditary disease he considered might be due to some unknown microbe which found its nutritive medium in the nervous tissues and was transmitted in the reproductive cells. The question whether micro-organisms can actually pass from parent to offspring is one which has been carefully investigated, whereas the proof that actual morphological changes, such as modifications of histological or molecular structure, can be transmitted has not yet been given. It is conceivable that predispositions may be inherited, and these must result from alterations in the germ plasm, or a direct infection of the germ or embryo might cause the transference of a disease from one generation to another, a phenomenon which simply depends upon a particular mode of conveyance of a parasite.*

In many diseases, and particularly those which are directly caused by micro-organisms, it is a matter of interest to note the wide differences which exist between the conveyance of hereditary characters and of a specific disease. Armauer Hansen has made this perfectly clear in considering the etiology of leprosy. He has pointed out that true hereditary characters are usually limited to one sex, frequently appear at a particular age, and the phenomenon of atavism is not rare; but in the conveyance of such a disease as tuberculosis or leprosy none of these conditions are fulfilled. It is a logical deduction from the consideration of these differences that every specific disease which is transmitted cannot be regarded as hereditary, but as an instance of the direct bacterial infection of the germ cells or embryo. Most writers on cancer and malignant growths have discussed the hereditary transmission of this disease, and if it is allowed that a disposition to cancer may be derived by inheritance, then this condition would depend upon some peculiarity inherent in the nucleus of the germ cells; but if, on the other hand, malignant disease is caused by a parasite belonging, as some investigators have sought to prove, to the group of protozoa or protophyta, then the transmission of the actual disease will depend upon the passage of a micro-organism which invades the germ or its product, and the whole phenomenon ceases to be one of heredity, for the hereditary transmission of micro-organisms is simply a particular instance of bacterial infection. The inheritance of actual specific disease must, therefore, always be considered as a problem absolutely distinct from that of heredity and incapable of explanation by any hypothesis of heredity.

Micro-organisms which reach an individual either by inheritance or other modes of conveyance may undoubtedly exhibit a period of latent life extending over many years; but when this condition is succeeded by an active life, to establish the proof of an hereditary transmission is exceedingly difficult or even impossible. The early researches into problems of this nature were necessarily made with the help of statistical and clinical methods, but it is the application of experimental methods, which could only be pursued with success as the study of bacteriology developed, that has finally succeeded in removing the subject of the hereditary transmission of specific diseases from the hazy region of speculation. The attitude assumed by Baumgarten and his followers on this question is well known. In the case of tuberculosis it is maintained that individuals are rarely infected with tubercle bacilli after birth, but that the disease in the majority of cases is due to a parasitic infection of the egg cell or embryo. It is even urged that the bacilli may remain latent in one individual, and only enter upon a phase of activity in the offspring, a view which, if correct, would accord with the opinion of many clinical observers. While destroying the opinion so commonly held that an "inherited tubercular predisposition" exists, Baumgarten's theory of hereditary parasitism makes a still greater demand on the imagination; but that the views of this distinguished pathologist have acted as a stimulus to renewed experimental work on the transmission of micro-organisms is beyond doubt. Recent papers by O. Lubarsch, of Rostock, and J. Csokor, of Vienna, give an admirable exposition of the present position of our knowledge on this subject of the transference of bacteria from parent to offspring in man and the lower animals, and the evidence that bacteria may in this manner gain access to the organism is incontestable.

In inherited specific diseases it is possible to distinguish two forms of infection: first, by a direct bacterial invasion of the essential reproductive cells; secondly, the egg cell or the embryo may receive micro-organisms from the female, in which case the blood stream is the channel for conveyance, and the whole phenomenon is then one of metastasis comparable in every respect to what obtains when bacteria multiply at a definite area of the body, and thence become distributed by the blood and lymph in distant parts of the organism. Bacterial infection may, therefore, be either germinative or placental, and in mammals the latter form of transmission is not infrequently observed. The specific bacteria of anthrax, typhoid fever, pneumonia and tuberculosis have been isolated from the human fœtus, cultivated, and successfully inoculated upon animals, so that the chain of evidence is complete. The pyogenic cocci such as streptococcus pyogenes and staphylococcus pyogenes aureus have also been demonstrated in fœtal tissues by Fraenkel and Kiderlen, and Auche has shown that in smallpox the placenta may be penetrated by these micro-organisms. In the lower animals not only may the bacteria already mentioned be transmitted, but also those of cholera, glanders and chicken cholera.

In many animals the egg cell is the largest unit of the organism, and would be capable of containing numberless bacteria; that such an infection does occur was first established by the classical observations of Pasteur, which have been confirmed by all subsequent investigators. In pebrine, a disease of silkworms, definite sporocyst forms (microsporidia or Cornalia's corpuscles) are transmitted from the imago in the egg cell, and the larva is directly infected in this manner. Blochmann has also described a similar mode of conveyance of bacteria in the ova of Blatta orientalis. In a single instance a tubercle bacillus has been seen in the mammalian ovum. The sperm mother cells may also be invaded by micro-organisms, but this is rare, and no example of an infected male reproductive cell exists. That this condition will ever be demonstrated is improbable, since bacteria contrast with parasitic protozoa in infecting the cell and sparing the cell nucleus, and the essential agent in the process of fertilization is the nucleus or head of the sperm cell.

Various observers have attempted a solution of this question of germinative infection by the employment of two different methods. The first of these is that pursued by Maffucci, who directly infected the fertilized eggs of the fowl, and in the second not only were the genital glands and the products of these examined for micro-organisms, but pieces of them were taken from animals suffering with specific diseases and used as material for inoculation.

Even if it is assumed that an ovum actually is a site in which bacilli such as those of tuberculosis exist, it may be objected either that the microbe is dead or that such a cell is incapable of development. This is the attitude taken by Virchow, who absolutely denies the existence of congenital tuberculosis. Maffucci's experiments, however, contradict this opinion, for this observer has shown that the bacilli of avian tuberculosis develop in an infected embryo, and the chicken succumbs to tuberculosis in twenty days to four and a half months after hatching. If, however, instead of infecting the embryo, bacteria such as those of chicken cholera, or anthrax, or Friedlander's pneumococcus are introduced in the extra embryonic area, then these organisms may actually enter the embryo through the allantois, but do not increase in number, provided the embryo remains alive. The pathogenic micro-organisms may, therefore, be destroyed or attenuated by actively proliferating embryonic tissue cells, or they may become capable of development at a later period of life, in other words, remain latent. Although these experiments were devised to establish the view that a genuine germinative infection may occur, they obviously do nothing of the kind, and it is to the researches of Gartner that we owe an absolute demonstration that ova may contain pathogenic germs. Gartner, among other animals, inoculated canaries with mammalian tubercle bacilli. After a few weeks he removed nine eggs, washed these in dilute corrosive sublimate, dried them in wool and introduced the contents of each egg into the peritoneal cavity of guinea pigs. In two cases tuberculosis was set up, the animals dying one and a half months and two and a half months after infection. These experiments, which are absolutely free from objection, conclusively prove that the egg cell may contain virulent bacteria, and it is easily conceivable that such eggs may develop and the transmission of the parasite take place by direct germinative infection, especially since Maffucci's work shows that such infected eggs are capable of development.

Jani, Westermayer, Spano, Walther, Gartner, and quite recently Jakh, have microscopically investigated the bacterial contents of the reproductive glands, and also inoculated animals with fragments of these organs. With the exception of Gartner's researches, these experiments have not added greatly to our knowledge of the hereditary transmission of bacteria. All the experiments of Westermayer were negative. In fourteen cases of well-marked general tuberculosis no tubercle bacilli could be recognized, and inoculation experiments were failures. The experiments of Jakh were more fortunate. Five inoculations with pieces of the male reproductive gland and its product, taken from individuals dead of tuberculosis, gave three positive results. If the gland alone was used, the experiments were always negative, and of three inoculations with pieces of the egg-forming gland one was successful. It may be admitted that these experiments do not really throw much light on the subject of germinative infection, but Gartner's researches are of much greater value. He experimented upon mice, guinea pigs, rabbits and canaries, these birds being susceptible to mammalian tubercle bacilli. Having inoculated these animals with bacillus tuberculosis, a careful examination was made of the offspring of such tubercular parents. This method might naturally be expected to give a conclusive answer to the question of hereditary infection, and the following information has been gained from these researches: 1. The sperm rarely contains tubercle bacilli—five in thirty-two cases. Even if micro-organisms exist, they are incapable of infecting the egg. In twenty-two (rabbits) and twenty-one cases (guinea pigs) where the male reproductive gland was the seat of an acute tubercular process, the offspring were never infected. 2. Neither does the male infect the female by way of the sperm. 3. Infection takes place frequently from the female to the fœtus, and in an overwhelming majority of cases by way of the placenta.

A few considerations may make the importance of Gartner's work more evident. If bacilli exist, as they occasionally do, in the product of the male gland, it is probable that this material, like other parts of the body, contains bacteria only a few days before death, for we know that quite an abnormal number of micro-organisms may invade the whole organism during the last days of life. Tubercle bacilli are immotile, and therefore will not easily reach the oviduct or egg, a matter of some importance, since it has been shown that in most cases the ovum is fertilized either high up in the oviduct or even at the time of liberation from the Graafian follicle. Stroganoff has also pointed out that the uterine area is sterile, and the secretion of this is bactericidal, in which it resembles sputum or the mucus of the nasal tract, which is almost free from germs. Lastly, it is well known that a single male morphological unit is sufficient for fertilization, and if we assume with Gartner that 100 virulent tubercle bacilli are mixed with sperm cells, the ratio of bacteria to these would be about 1 : 22,500,000; it is hardly conceivable on the doctrine of probabilities that a bacillus would gain access to the egg. It may, therefore, be considered, both on experimental and theoretical grounds, that a germinative infection of the ovum never occurs by the conveyance of micro-organisms in the male reproductive cells.

The difficulties which exist in proving that the inheritance of a specific disease may occur through an infection of the ovum are fortunately not so great in those cases where the passage of micro-organisms takes place solely from the female to the fœtus by way of the placenta. It is established that specific micro-organisms can pass by this route. It is not even necessary to assume that there is any lesion whatever in the placenta, or that the epithelium of the fœtal villi is destroyed. An experiment by Zuntz shows clearly that particulate material will easily pass into the amniotic fluid from the maternal portion of the placenta, for if indigo carmine is injected into the veins of the female the dye passes into the amnion, leaving the fœtus free, and in this very manner anthrax bacilli may pass, and from the amnion gain access to the mouth of the fœtus, enter the gut and set up disease by a primary infection of the wall of the intestine. An intra-uterine infection, therefore, can occur without lesion of the placenta, though in the majority of cases this structure is primarily infected, and then the fœtus, or else hemorrhages of the placenta permit the passage of micro-organisms. However, the undoubted fact that micro-organisms can penetrate the healthy skin by way of the hair follicles—and the same is possibly true for the epithelium of the urinary tract—must not be forgotten in considering the passage of bacteria across the placenta. This structure may be normal, and even then allow the transit of bacteria. Birch-Hirschfeld from researches on the structure of the human placenta as well as that of mice, rabbits and goats, considers that the bacilli of anthrax at any rate can traverse the uninjured chorionic epithelium. Moreover, in the human placenta and in rabbits numerous processes of the chorion traverse the placental sinuses, and these processes are normally destitute of epithelium. It was noticed by Max Wolff that anthrax bacilli easily pass if the placenta was crushed or torn, and micro-organisms which exert a necrotic influence on tissues, such as the pyogenic cocci, appear first to destroy the epithelium of the chorionic villi, and then pass through into the fœtal blood. In this fluid micro-organisms reach the liver, and it is this organ which, as a rule, is primarily affected, and then the glands in the lymphatics leading from the organ become implicated. The location, therefore, of tubercles in fœtal tuberculosis is characteristic, and all observers insist upon this feature in determining whether tubercular deposits are of intra or extra uterine origin in early cases of the disease. As a matter of interest it may be mentioned that quite recently Bar and Renon have demonstrated tubercle bacilli in the blood of the umbilical vein. The method used by these observers, that of inoculating guinea pigs with the suspected blood, and in this manner establishing tuberculosis, is not so convincing as the actual demonstration of bacteria in fœtal tissues. Wassermann in a recent paper especially insists on this point, and discards all evidence of inherited disease which rests simply upon inoculation experiments. He describes a case of early tuberculosis which ended fatally when the child was ten weeks old, where the disease was acquired, not from the parents, who were healthy, but by direct infection from a tubercular relation, and believes that such cases as these are not infrequently cited as instances of congenital disease. In his opinion hereditary transmission of bacteria does occur, but it is exceedingly rare in comparison with the frequency of extra-uterine infection. Bernheim considers that the offspring rarely, if ever, become tubercular if separated from tubercular parents, with the exception of those cases where the placenta is infected. The case reported by Ivan Honl of a child fifteen days old that on autopsy showed tubercular nodules in the liver, spleen, and lungs, and numerous bacilli, must be classed as a definite case of transmission which with many others lends no support to Eberth's statement that individuals do not inherit tuberculosis, but acquire it.

A recent case of congenital typhoid fever is related by Freund and Levy, and instances of transmitted hemorrhagic infection have been recorded by Neumann and by Dungern. The numerous examples which the journals of veterinary science contain, especially the work of Bang, Kockel and Lungwitz, also afford conclusive evidence of the transmission of pathogenic micro-organisms, though there is a consensus of opinion that the placental is far more frequent than the germinative infection. The share borne by the male in this transmission may be disregarded, as no bacteriological evidence exists to support this view. Finally, the frequency of hereditary

* "Pour les maladies, vraiement constitutionnelles, c'est la substance héréditaire elle-même qui est vicease; pour les maladies infectieuses, le vice n'est pas dans la substance elle-même, mais à côté d'elle, et les produits sexuels servent seulement de vehicule à un parasite capable d'engendrer plus tard une maladie générale." Y. Delage, La Structure du Protoplasma et les Theories sur l'Hérédité. Paris, 1895.

transmission of pathogenic germs is exceedingly small compared to other modes of infection.—From Science Progress.

BERTHELOT'S CONTRIBUTIONS TO THE HISTORY OF CHEMISTRY.*

MARCELLIN BERTHELOT, professor of chemistry in the Collège de France, Perpetual Secretary of the Academy of Sciences, Senator, Minister of Public Instruction and recently appointed Minister of Foreign Affairs, known to the scientific world by his masterly researches in synthetical chemistry, has added to these honors that of editing the most important and far reaching documents pertaining to the history of chemistry ever brought to light.

The six handsome quarto volumes published by him between the years 1887 and 1893 contain the most ancient Greek, Arabic, Syriac, and Latin treatises on alchemy and technical chemistry preserved in the great libraries of the Old World. Besides reproducing the original text of these precious manuscripts, these volumes contain complete translations of many treatises, analyses of the contents of others and critical studies of their mutual relations, their sources and authorship, as well as erudite essays on the chemical knowledge exhibited in them. The six volumes form two distinct works; three of the volumes bear the title: "Collection des anciens Alchimistes Grecs," and three of them, "La chimie au moyen age," each volume having, moreover, specific sub-titles more exactly indicating its contents.

Not having seen any adequate review of these works in English, I propose in this article to examine their scope, contents, and manner of treatment, as well as to show some of the more important changes resulting from Berthelot's historical studies. The existence of ancient Greek and Arabian manuscripts had long been known; Reuvens, and later Leemans, of Holland, had published summaries of certain papyri preserved in Leyden, more than forty years before, but in such a fragmentary manner as merely to excite curiosity. Ferdinand Hoefer, the French historian of chemistry, and Herman Kopp, the erudite German, had made partial use of some of the manuscripts, but it remained for Berthelot to collect and compare the diverse copies, to reproduce and translate them for the benefit of students. This he could scarcely have accomplished without the aid of the French government, both series being "published under the auspices of the minister of public instruction." Government co-operation was brought about through a report made by Berthelot to the "comité des travaux historiques et scientifiques," and adopted by them in 1884. This report directed attention to the existence of Greek alchemical manuscripts and to the utility of their publication, owing to the great light they throw on the history of natural science, the technology of metals and ceramics and the history of philosophy in the first centuries of the Christian era.

The difficulties of deciphering, transcribing, and editing Greek, Arabic, Syriac and Latin manuscripts were prodigious, and Berthelot was fortunate in securing scholars of eminence to assist in the task. In dealing with the Greek papyri, he was aided by Ch. Em. Ruelle, of the Bibliothèque Sainte Geneviève, Paris, and by André Berthelot, son of the editor; the Arabic scholar, Professor Houdas, and the Syriac linguist, Rubens Duval, also contributed their learning, each in his own sphere.

The "Collection des Alchimistes Grecs" opens with an "Introduction" by Berthelot, which occupies 268 pages; this forms an important contribution to the history of chemistry, based upon a critical study of the ancient treatises; he agrees with other historians in tracing the birth of alchemical ideas to Egyptians, whence they reached Europe through Greeks.

Certain Greco-Egyptian papyri, preserved in Leyden, are of the greatest interest; several of them treat of magical formulas, incantations, love philters, dreams and similar gnostic notions; one of them, known as "Papyrus X," is a treasury of information on metallurgical operations, at so early a period as the third century of the Christian era. It was found in a tomb at Thebes, secured by the Swedish consul at Alexandria, Anastasi, and presented by him to the Netherlands in 1828. Berthelot conjectures it is one of the ancient Egyptian books on the preparation of gold and silver, which escaped the destruction ordered by Diocletian in 290; an order issued lest the people using them should grow rich by their art and revolt against the Romans.

This precious document contains one hundred and one chemical and alchemical recipes, followed by ten paragraphs taken from Dioscorides. The recipes are for making alloys to be used in the manufacture of cups, vases, images, and other objects of the goldsmith's art, also processes for soldering metals and superficially coloring them, besides formulas for making gold and silver inks. The text is full of grammatical errors and ignorant spellings, which show the writing to have been the work of an uneducated artisan; the recipes are not arranged in order, several appear in duplicate; they exhibit no indication of chicanery, although some of the methods are unprofitable. The whole papyrus, in short, is evidently the memorandum book of a goldsmith (or silversmith) engaged in attempts to imitate gold and silver for fraudulent purposes. Only one author is cited, "Phimenas," who is probably Pammenes, author of recipes occurring also in other manuscripts. The preparation of asem, an amalgam of copper and tin, plays a prominent part among the recipes for imitating gold. But time forbids a full analysis of this remarkable manuscript; as a result of Berthelot's careful study of this and analogous treatises, he comes to the conclusion that the doctrines of alchemy concerning the transmutation of metals did not originate in the philosophical views of the constitution of matter, as generally supposed, but in the practical experiments of goldsmiths occupied in making fraudulent substitutes for the precious metals. The "Introduction" contains a chapter on the relations between the metals and the planets, of Chaldean origin, and constant occurrence in the early writings, which is illustrated by facsimiles of several manuscript pages. Another chapter is devoted to the figures of apparatus occurring in the treatises of the eleventh to fourteenth centuries; these include water baths, digestors, aludels, alembics and a great variety of apparatus for distillation.

The sixth chapter of the introduction is divided into twelve sections; these deal with several Greek manuscripts, notably those preserved in the libraries of St. Mark, Venice, the Escurial, the Vatican, Rome, Gotha, and in Munich, appertaining to the eleventh to fourteenth centuries; of these we note only a few features. At the beginning of the MS. of St. Mark is one of the earliest of chemical bibliographies; it gives the title of fifty-two treatises, verily not in modern style, yet quite suggestive; among them are the following: "Emperor Heraclius, eleven chapters on the manufacture of gold." "Justinian, five chapters on the secret art." "Heliodorus, on the divine art." "Theophrastus, verses on this art." "Moses, on the diplosis (doubling) of gold." "Lexicon of the gold maker, in alphabetical order."

This association of names of emperors of Rome, Greek classical writers and the Hebrew law giver with chemical and alchemical treatises is characteristic of the period at which they were compiled and by no means denotes actual authorship; the names of prominent men were given to the treatises in order to add to the dignity and authority of the writings. This custom prevailed as late as the sixteenth century, and in certain cases to be noted hereafter, gave rise to undeserved honors. An entire group of writings have been ascribed to Democritus, giving rise in Egypt to what may be styled the school of Democritus. A certain Zosimus of Panoplis is credited with a veritable encyclopedia of the sacred art, a work which occupies ninety pages of Berthelot's volume.

The Collection des Alchimistes Grecs comprises no less than 160 different treatises on the science of Hermes. Many of these are fragmentary in the extreme, extending to only six lines, and even less. All are composed in an archaic, enigmatical style, combining in one undecipherable medley chemical terms of obscure meaning, magical formulas, astrological notions, citations from mythical authors, and mystical allusions to a philosophy long since buried too deep for present resurrection. It is not surprising that commentators early felt the need of lexicons of the sacred art, and such are preserved in these volumes; unfortunately, however, the definitions are no clearer than the words defined; one word was often used for a score of different objects and processes, and a single article was known by a dozen different names. To convey to readers any idea of these extraordinary literary productions by citations is hardly practicable in the space available, for passages lose much when removed from their original settings. The actual chemical knowledge exhibited in these ancient manuscripts is varied, and yet indefinite, owing to the numerous obscure expressions; the authors were acquainted with a large number of ores, minerals, earthy substances, and saline bodies, as well as vegetable and animal products, but their ignorance of the mineral acids and their important derivatives limited them to products obtained by aqueous solution, distillation and the action of heat. Of scientifically classified knowledge there is no trace; the alleged opinions of mythical writers are given as authoritative, and information is imparted in the tedious form of dialogues between philosophers, who remind one of the Scotchman's definition of metaphysicians: "Poor bodies discussing things of which they know nothing, in a language neither of them can understand." Many of the writings contain reverent acknowledgments of the Deity and other evidences of piety. There is a good deal of duplication, arising from the introduction into an essay of passages from another, generally without acknowledgment.

Berthelot remarks incidentally that the term Philosopher's Stone does not occur in writings earlier than the seventh century, although the central idea is much more ancient.

Each of the three quarto volumes which constitute Berthelot's "La chimie au moyen age" bears an independent title; that of the first volume reads: "Essay on the transmission of the knowledge of Antiquity to the Middle Ages; transmission of technology; translations of Arabico-Latin treatises, with a new version of the Liber Ignium of Marcus Graecus, and an original edition of the Liber Sacerdotum."

This volume covers the period from the fall of the Roman empire to the thirteenth century, thus filling the gap between the ancient Greek alchemists and the Latin writers of the later epoch, a period which had been previously unworked or misunderstood. Berthelot finds that the transmission from the earlier to the later era was accomplished by two agencies; first through the Arabians, who succeeded to the literary and scientific wealth of the Greeks. The Arabic treatises, preserved in the Mohammedan libraries of Spain, were translated into Latin and thus became for western nations the sources of their knowledge in medicine, alchemy, mathematics and philosophy. Some of these translations were collected and printed in the seventeenth century in the works entitled Theatrum chemicum (5 vols., 1613–22) and Bibliotheca chemica, of Mangetus (2 vols., folio, 1702), and Berthelot discovered in these Arabico-Latin treatises entire passages from the ancient Greek alchemists.

The connection between the Greeks and Arabians was not, however, immediate, but through the Syrians, who were among the first to translate the philosophy and science of the Greeks into an Oriental tongue. These Syriac versions form the subject of the second volume.

A second link between the Greeks and the Latin alchemy was more directly forged, though difficult of recognition; the processes used in industrial arts and metallurgical operations by the Greeks had been adopted by the Latins as early as the time of the Roman empire, and this chemical technology was preserved through centuries of intellectual degradation to the beginning of the middle ages.

The most ancient Latin treatises on chemical technology are the Compositiones ad tingenda, dating from the close of the eighth century, and the Mappæ clavicula, written before the tenth century. These are collections of recipes for industrial processes analogous to those in the Leyden papyrus, and forming links in a chain that extends from that ancient work through the treatises of the middle ages to the modern "Workshop Recipes" and "Manuels Rorets." The full title of the Compositiones ad tingenda is as follows: [Translation.] "Recipes for coloring mosaics, skins and other objects, for gilding iron, for using minerals, for writing in letters of gold, for soldering metals, and other technical documents." The following are some of the subjects treated: The coloring of artificial stones, used in the manufacture of mosaics; the manufacture of stained glass; the dyeing of skins in purple, green, yellow and reds; the dyeing of wood, bone and horn; a list of ores, metals, earths and metallic oxides used in jewelry and in painting; a number of recipes for gilding on glass, wood, skins, garments, and the metals. All these topics are treated in barbarous Latin, bordering on a species of jargon; some were originally written in Greek and copied by ignorant scribes in Latin letters, which shows the influence of Constantinople. In one of the sections on ores, the word "vitriol" occurs for the first time, being the eighth century, and in the correct significance of an impure ferrous sulphate. A very rational grouping of substances occurs in this work. The minerals and earths are by themselves, then follow gums, resins and other products of plants, and thirdly, substances derived from the ocean, such as salt, coral and mollusks yielding purple dye. A certain recipe for writing letters of gold is practically identical with one in the Papyrus of Leyden.

A formula for making bronze shows the origin of this name, De compositio brandisii, Brindes being a synonym of Brundusium (Brindisi), a town noted in Pliny's day for its metallic mirrors.

A large part of Compositiones ad tingenda is reproduced in the work entitled Mappæ clavicula, of which the earliest known manuscript dates from the tenth century. This latter treatise contains recipes for making gold, for multiplying gold and imitating the precious metal, closely resembling those of the ancient Greek papyri. In this connection cautions are given to conceal the secrets, and an incantation is prescribed to be used during the operation. Exceeding interest attaches to the fact that the use of the hydrostatic balance in analysis of an alloy is clearly described, for this proves that the knowledge of this instrument did not pass through Arabian channels, and possibly came down direct from Archimedes.

The Liber ignium ad comburendos hostes, by Marcus Graecus, is one of the most ancient Latin treatises on Greek fire, dating from the twelfth or thirteenth century, and is probably a translation from an earlier Greek work transmitted through Arabian channels. It deals with instructions for making Greek fire, so called, phosphorescent materials, fireproofing substances, and the preparation of fuses and petards, composed in part of saltpeter. Greek fire itself, however, dates from the second century B. C., and phosphorescent stones are named in the much earlier Greek alchemical manuscripts.

Berthelot devotes an interesting chapter to the discovery of alcohol. This product of distillation first appears under the name aqua ardens, and the term alcohol in its present signification does not occur before the middle of the fourteenth century; the term spiritus vini is also comparatively modern, and aqua vitae seems to have been applied to alcohol for the first time by Arnald de Villanova, who died in 1314. The fact that wine yielded an inflammable substance was, however, already noted by Aristotle, but this body was not isolated. Rhases has been given credit for acquaintance with alcohol, but this is erroneous.

The preparation of alcohol by distilling wine is, however, mentioned in a copy of the Mappæ clavicula, written in the twelfth century, and in the Liber ignium of Marcus Graecus.

In attempting to trace to their origin Latin treatises which claim to be translated from Arabic, Berthelot made the important discovery that they are fraudulent, the Arabic manuscripts having no existence. Thus the chemical works attributed to the Arabian physician Jabir ibn Hayyan (Abu Musa), commonly called Geber, are shown to be fictitious, and the great reverence paid to him as a pioneer in chemistry has been misplaced. The whole history of chemistry has been falsified by giving credit to the Arabians for knowledge which really belonged to a period five hundred years later.

Yet the historical personage Geber, who lived in the ninth century, left many treatises in Arabic, now preserved in Paris and Leyden, and the translation of these occupy 100 pages of the third volume; they are very different from the works so widely known as Geber's, which are found in Latin, French, German and English.

In like manner the current alchemical treatises ascribed to Raymond Lully are shown to be fictitious, yet his works on philosophy in the Provençal language are extant.

The Pseudo-Arabic works in their Latin form contain, however, traces of the ancient Greek alchemical writings, and to endow them with authority the writers referred the text to mythical personages; and as these were cited by later authors who did not doubt their genuineness, the pseudo-treatises acquired undeserved renown. Students of alchemy who have been reveling in the works of Morien, Kalid, Zadith, Mary, and the collection of citations entitled Turba philosophorum, are loth to have their antique idols shattered, but this is the fate of every branch of human knowledge when subjected to the modern methods of searching analysis.

The second volume of "La chimie au moyen age" has the subtitle: "Syriac Alchemy, comprising an introduction, and several treatises of Syriac and Arabic alchemy from the manuscripts in the British Museum and Cambridge; text and translation."

The existence of Syriac alchemical manuscripts in the British Museum was pointed out to Berthelot by Prof. Richard Gottheil, of Columbia University, New York City. The most important of these, entitled "The Doctrine of Democritus," was translated from Greek between the seventh and ninth centuries. It begins with a charge of self-purification, followed by a key to the symbols used in the manuscript; these signs resemble in part those occurring in the writings of the earlier Greek alchemists. The first section of the "Doctrine" is called "The Preparation of Gold," the second is called "On the Philosopher's Stone," and the succeeding parts contain a collection of recipes, processes with metals, as well as with sulphur, antimony, arsenic, and ores, analogous to the Leyden papy-

* Read before the Washington Section of the American Chemical Society, March 12, 1896. [Reprinted from the Journal of the American Chemical Society, vol. xviii, No. 5, May, 1896.]

rus and the Mappæ clavicula. Rude drawings of apparatus accompany the text. The writer shows acquaintance with a very large number of chemical substances.

The Library of the University of Cambridge possesses a Syriac manuscript which is a translation of portions of the Greek writings of Zosimus, Democritus, and others. It is similar in character to the preceding.

Volume III of "La chimie au moyen age" has the subtitle: "Arabian Alchemy, comprising an historical introduction, the treatises of Crates, el-Habib, Ostanes and Djaber from manuscripts in Paris and Leyden; text and translation."

The Arabic treatises here named are the genuine writings, not the fictitious ones known only in Latin. The first Mohammedan writer on alchemy was Khaled ben Yezid ibn Moaouia, Prince Omeyyade, who died in 708; he is a historic personage and the reputed teacher of Djaber. Only the titles of his works have come down to us. Djaber, the Geber of the Latins, was, however, the great master of the art and enjoyed the highest reputation throughout the middle ages; he is credited with 500 treatises, an Oriental exaggeration. Six of these are here collected and translated. They exhibit evidence of Moslem faith on the part of the author; he shows familiarity with the hydrostatic balance, with many species of minerals (of which an ingenious classification is given), and he discourses on the changes in volume produced by heat and by cold, at the same time he admits using allegorical and obscure language in all his works. There is no reference to the mineral acids, to nitrate of silver and other chemicals that Geber is supposed to have known. Perhaps the most clever passage in his works is the following from the "Book of Mercy:"

"I saw that persons engaged in attempts to manufacture gold and silver were working ignorantly and by wrong methods; I then perceived that they were divided into two categories, the dupers and the duped. I had pity for both of them."

Berthelot's superb volumes comprise more that 2,000 pages, and much of the contents defies review. Besides these original documents he has published two works dealing in more popular style with the periods of alchemy and middle age chemistry. These are entitled: "Les Origines de l'Alchimie" (1885) and "Introduction à l'Etude de la Chimie des Anciens et du Moyen Age" (1889); the latter is largely reprinted in the quarto volumes. All are charmingly written, well illustrated, and well indexed.

Berthelot had extraordinary qualifications for the task and enjoyed unrivaled opportunities, and the result is a magnificent contribution to the history of chemistry, of utmost interest to the chemical student as well as to the philosopher.

H. CARRINGTON BOLTON.

ON THE DIFFRACTION AND THE POLARIZATION OF THE ROENTGEN RAYS.

By G. SAGNAC.

I. To obtain real images of a luminous slit with a grating by transmission at equal intervals, we place it in front of a real image furnished by a converging sheaf of rays. We cannot do this with the Roentgen rays, which diverge on the exterior of a Crookes tube, and for which we have no lenses. To obtain real images of a slit I have diaphragmed the entrance into a large camera by a second slit, behind which is placed the grating.

I used a grate of $\frac{1}{12}$ mm., constructed by M. Gaiffe, with platinum wires of nearly $\frac{1}{10}$ mm. in diameter. The lower part of a luminous sheaf, defined by two metallic slits at the distance of 7·5 cm., passes below the metallic mounting of the screen, and forms—on ground glass of the camera at 35 cm. beyond the screen—a real image of the first slit. The upper part of the same sheaf traverses, at 2·5 cm. behind the second slit, the screen placed at the incidence of 45°, which here augments the deviations and the intensities of the diffracted rays. These latter add to the direct image so many diffracted images, four of which are especially very distinct. These five images of the first slit, supposed to be rather narrow ($\frac{1}{25}$ mm.), reinforce themselves by being partially superimposed, and form thus an image of a fluted aspect, broader by about 7 mm. than the lower image without diffraction.

We regulate the parallelism of the edges of the slits among themselves and with the wires of the grating. For this purpose we realize the maximum distinctness of the diffraction fringes of the second slit illuminated by the former, rendered fine, then that of the shadows of the wires of the grating given by the second slit, rendered fine in its turn, the former being enlarged up to 1 mm. We then enlarge the second slit until the shadows of the wires are seen to disappear.

For the source of light illuminating the slit we substitute a Crookes tube, and for the plate of ground glass a frame charged and closed. We have obtained a very well defined proof.* We must seek to recognize in it the diffraction of a greater breadth of the upper image. If this image exceeds the lower image in breadth, such excess is certainly not more than $\frac{1}{25}$ mm. It differs from the lower image solely by a width of 2 mm. on each margin, where it presents seven appearances of fringes; but these apparent fringes correspond to the juxtapositions of the margins of the first slit given by the transparent intervals, to which the second slit limits on the screen the pencil of rays coming from each margin of the first slit.

Further, we substitute for the Crookes tube the flames of common salt, on exposing for about an hour with an open frame, and, using an orthochromatic plate (sensitive to yellow and green), we obtain a proof differing from the former by a fluted upper image enlarged by more than 7 mm., even if we neglect the most intense parts of the margins. Now the appearances of five fringes of the former proof reoccur here between the broader flutings, as well in the last diffracted images as on the margins of the central image, and the simple nature of the light employed does not permit them to be considered as due to diffraction by the grating; they are certainly phenomena of shadows just explained. These same images of the margins of the first slit are certainly not very visible on proofs obtained with an open frame, either with ordinary gaslight or with the light of a Crookes tube, on account of the complication which the nature of the sources employed impresses on the diffracted flutings, especially if the sensitive plate is orthochromatic.

The expansion of the copper sheaf by diffraction, if it exists at all, does not exceed $\frac{1}{2}$ mm. or scarcely $\frac{1}{4}$ mm. Now an expansion of $\frac{1}{2}$ mm., fourteen times less at least than that given by the light of the D ray, would correspond to a wave length of 0·04 μ.

This enables us to conclude that the Roentgen rays which have acted on the sensitive plate through the wooden shutter of the frame do not possess wave lengths exceeding a hundredth of a micron.

II. Are the Roentgen rays connected to a vector either longitudinally or transversely, and in the latter case how can they be polarized?

We cannot at present dream of polarizing them by reflection, nor by refraction, nor doubtless by diffraction. Emission and diffusion might perhaps be tried. It is in any case simpler to attempt to polarize them by absorption. Let there be two crystalline plates, near to each other in thickness, parallel to the axis, superimposed with their axes parallel. Let us divide the surface of the upper plate in two halves, and cause one of them to turn by 90°. The system of the plates realizes at once the analogue of the crossed tourmaline and of parallel tourmalines. With a monochromatic light the amplitude 1 becomes, when issuing from a plate, for the components perpendicular and parallel to the axis, respectively o and e, which differ if there is dichroism. The region of the principal parallel sections allows an intensity to pass, the excess of which over that of the other region is measured by $(o^2-e^2)^2$.

Otherwise for the differences (o—e) possibly of different signs, relative to different wave lengths, the corresponding differences of intensity accumulate always in favor of the region where the principal sections are parallel.

I have sought if the effect is produced with the Roentgen rays when such system of three plates are arranged on the double black paper which covers the sensitive plate. The time of exposure was increased to several hours. The proofs obtained with the desirable intensity have not revealed a sensible dichroism.

Substances used.	Quartz. mm.	Spar. mm.	Brown tourmaline. mm.	Mica. mm.	Potassium ferrocyanide. mm.
Thickness of each plate	0·03	0·4	0·5	0·2	0·4 to 2

One precaution is indispensable to eliminate the influence of a small difference of nature, such as occurred in the tourmalines; we cause each of the two upper half plates to turn on the spot by 90°, so that the regions of the principal parallel sections and of the crossed sections are mutually interchanged. A difference of intensity due to dichroism ought, in its displacement, to follow the parallelism of the principal sections. Now the very small difference of intensity perceived with the tourmalines always persisted in the same half plate.

If the method admits of so easy a check, and is found independent of the complexity of the radiations employed, it is unfortunately not very sensitive. We see readily, in the case of light, that to detect a difference, e. g., of 1/10 between unity and the relation $\frac{o}{2}$, the photograph must be able to show a relative difference of 1/50 between the luminous intensities which act upon two contiguous regions, which far exceeds that which may be hoped.

We cannot, therefore, derive from these negative experiments on dichroism an argument of great value in favor of the hypothesis of a longitudinal vector. They supply merely a further distinction between the X rays and the luminous rays which we know.—Comptes Rendus, cxxii.

ON THE MECHANICAL ACTION EMANATING FROM CROOKES TUBES.

By A. FONTANA and A. UMANI.

IN the Comptes Rendus for March 23 there was published a paper by J. R. Rydberg "On Mechanical Action emanating from Crookes Tubes." We must make known that we have developed this subject in a memoir published in the Rendiconti della R. Accademia dei Lincei (vol. v, March 1, 1896), entitled "Azione del Tubo di Crookes sul Radiometro."

We have observed the facts described by Gossart and Chevalier (Comptes Rendus, Feb. 10, 1896), but contrary to the conclusion of these authors, we have found that the mechanical action is due to charges of statical electricity, and not to the rays of Roentgen.

We have reproduced these facts without the intervention of a Crookes tube, with the aid of a Leyden jar. On the other hand, we have pointed out that the mechanical action upon the wings fades away when we shut up the Crookes tube, and the coil or the radiometer, in a metallic chest placed in communication with the earth.

We have also studied the action of various diaphragms, and observed that the permeability, greater or smaller for the X rays, has no influence on the directive force of the tube, and, on the contrary, that diaphragms which are good conductors of electricity in connection arrest the mechanical action, while dielectrics do not arrest it.

We believe, therefore, that we have been the first to exclude all relation between the rays of Roentgen and the phenomena observed with the Crookes tube, and to deny the accuracy of the method proposed for measuring the intensity of the X rays.—Comptes Rendus.

Bass & Company, of Burton-on-Trent (Bass' ale), England, got up an excursion for ten thousand of their employes recently, taking them to Blackpool in seventeen trains. They had hired every show in the place and opened them free to the excursionists, besides providing steamers for a sea trip, free railroad tickets, and enough money to pay for the incidentals.

* The Crookes tube, manufactured by M. Chabaud, has acted for eleven days, on an average five hours daily, without becoming sensibly weaker, and becoming heated less and less rapidly.

SELECTED FORMULÆ.

Safety Matches.—For match heads the following compositions are used:

	a	b
Chlorate of potassium	2,000	2,000
Binoxide of lead	1,150	2,150
Red lead	2,500	2,500
Trisulphide of antimony	1,250	1,250
Gum arabic	670	670
Paraffin	250	250
Bichromate of potassium	1,318	....

Rub the paraffin and antimony together, and then add to other ingredients. Enough water is added to bring the mass to a proper consistency when heated. Conduct heating operations on a water bath. The sticks are first dipped in a solution of paraffin in benzine and then dried. For striking surface, mix 9 parts red phosphorus, 7 pulverized iron pyrites, 3 pulverized glass, and 1 of gum or glue, with water q. s.

Insecticides.—

ANTS.

1.—Cape aloes ..... 4 ounces.
Water ..... 1 quart.
Boil together and add to the mixture camphor, in small pieces .. 1½ ounces.

This can also be used for other insects by means of a water sprinkler.

The use of turpentine by means of an oil can, or powdered borax, sprinkled around the infested places, is also said to be very effective.

2.—Quicklime, powdered ..... 20 parts.
Camphor, powdered ..... 1 part.

BEDBUGS.

1.—Kerosene ..... 1 quart.
Common soap ..... 1 ounce.
Water ..... 1 pint.

Heat the solution of the soap in the water, and when boiling hot add the kerosene, churning constantly until a perfect emulsion results.

This solution may be diluted with from 10 to 15 parts of water, if desirable, and can be used for plant lice and other insects as well.

This is considered to be a most excellent preparation.

2.—Soft soap ..... 1 part.
Soda lye (10 per cent.) ..... 5 parts.
Water ..... 15 "

FLEAS.

1.—Expressed oil bay ..... 1 part.
Oil eucalyptus ..... 2 parts.
Ether ..... 2 "
Alcohol ..... 7 "

Dissolve the expressed oil of bay in the ether, and the oil of eucalyptus in the alcohol. Mix the two solutions, and filter rapidly in a covered funnel. This compound may be used for domestic animals as well as man, or it may be placed about the house.

This preparation is also good for banishing flies and mosquitoes:

2.—Ox gall,
Oil camphor,
Oil pennyroyal,
Extract gentian,
Alcohol. ..... equal parts.

The above is especially intended for fleas on dogs, horses and cattle.

MOSQUITOES AND FLIES.

1.—Oil patchouli ..... 0·015
Oil cinnamon ..... 0·015
Sandal wood ..... 4·0
Alcohol ..... 100·0

2.—Sodium boro-salicylate ..... 1 part.
Decoction quassia ..... 50 parts.

3.—Carbolic acid, liquefied ..... 1 volume.
Oil pennyroyal ..... 2 "
Spirit camphor ..... 2 "
Oil tar ..... 4 "
Glycerin ..... 2 "
Lard oil ..... 4 "

The above is known as "mosquito oil," and is largely used to keep flies and mosquitoes off horses and cattle.

Preparation of Formaldehyde Gelatin.—The difficulty which has been experienced in completely drying and powdering formaldehyde gelatin has been overcome by Van Vloten (Chem. Zeit.) by beating the gelatin solution into a froth and allowing it to cool completely and harden in this form. He recommends the following process: Dissolve a sufficient quantity of first quality gelatin in about four times its own weight of water; pour this solution into a previously warmed mortar; add the requisite quantity of 40 per cent. formaldehyde solution and mix thoroughly. In consequence of the thin consistence of the gelatin solution the reaction proceeds slowly, so that one has sufficient time to beat the solution into a froth by means of an egg beater. On allowing to stand a short time a small quantity of liquid settles to the bottom, and before congealing the foam may be put into any desired receptacle. If the gelatin solution be too dilute, a liquid separates out on standing a short time. The formaldehyde gelatin foam resembles very much the dried, beaten white of eggs and may be easily reduced to powder.—American Druggist.

A New Test for Sugar.—A new test for sugar in the urine is made by dissolving 2 gme. of salicylate of sodium, 2 gme. of salicylate of copper, and 8 grm. of sodium-carbonate crystals in 100 c. c. of distilled water. Add an equal volume of the reagent to the urine to be tested, and apply heat until a precipitate is thrown down. The presence of glucose will be indicated by a yellow deposit, the suboxide; and the contrary will be shown if the precipitate is of a grayish or black color, representing the binoxide.—American Medical-Surgical Bulletin.

Leather Dressing.—

Cresin, yellow ..... 1 part.
Palm oil ..... 1 "
Lard ..... 5 parts.
Heavy petroleum oil ..... 4 to

—Seifenfabrikant.

ENGINEERING NOTES.

The Orleans Railway, France, says Engineering News, reports great success in suppressing dust from sand ballast by covering the roadbed with a 2½ in. bed of broken stone. It is said that the cost is one-fourth that of stone ballasting, and that large saving to rolling stock results from suppression of dust.

Batoum harbor has now been deepened to 26 ft. at the point where naphtha is loaded. The mole will be run out to a length of 1,750 ft., so that the harbor may be used by the Black Sea fleet in all weathers. Russia has already spent 5,000,000 rubles on the port and has just appropriated 750,000 rubles more.

Our Austrian contemporary, the Zeitschrift fuer Elektrotechnik, gives the following table showing the number of rides on passenger railways taken per year by each inhabitant in a number of cities:

In New York	267	In Paris	84
" Berlin	140	" Budapest	59
" London	116	" Vienna	46
" Hamburg	90	" Prague	22

The Chicago Belting Company is constructing a monster belt, the dimensions being as follows: Length, 150 ft.; width, 7 ft.; weight, 3,300 lb.; thickness, ⅞ in. In its construction the selected portions of 450 oak tanned hides, picked from over 5,000 skins, were used. The belt is to be used in the engine room of the Louisiana Electric Light Company, at New Orleans, where it will be attached to the 28 ft. driving wheel of a great Allis-Corliss engine. A Chicago exchange says that this is confidently stated to be the largest belt ever constructed.

According to a well informed service journal, the Italians will this year confine their shipbuilding programme to the construction of two new ships, a not very formidable showing for a nation that has ranked among the leading naval powers. One of the vessels is to be only of 1,100 tons, her length being 275½ ft. and beam 26 ft. Her engines will be of 7,000 horse power, to give a speed of 22 knots. The other vessel, however, is to be an armored cruiser, 10,500 tons displacement, the length being 419 ft., beam 65½ ft., and draught 25½ ft. The engines, it is said, will be of 13,000 horse power, and the speed 23 knots.

Although pure aluminum is well known to retain its luster and not to corrode, even in moist air, much of the metal now obtainable becomes soon covered with spots of a white incrustation, even when in a moderately dry atmosphere; a matter easy to understand when looked at by the light of M. Moissan's statement that commercial aluminum often contains from 0·1 to 0·4 per cent. of sodium. This sodium, instead of being equally distributed, is often so local that the highly contaminated parts form an electric couple with the purer aluminum, and aluminate of sodium is probably first formed, this being subsequently decomposed by moisture with the liberation of alumina, while the alkali acts as a virtual carrier of oxygen to fresh portions. The evil of the presence of sodium being once recognized, there should be no difficulty in eliminating it. Carbonaceous particles appear also to form "couples" in aluminum.—Amateur Photographer.

Again we hear of the Galveston and Corpus Christi Canal enterprise. Now, writes the Modern Miller, a new corporation has taken the matter in hand, and it is reported that the business men of both Galveston and Corpus Christi are lending the movement substantial aid. The distance from Galveston to Corpus Christi is about 200 miles, and the present route is via the Gulf of Mexico, being one of the most dangerous portions of that great body of water. The southern shore of Texas is bordered by a succession of islands, capes and peninsulas that, when the gulf current and frequency of gales are considered, constitutes a perilous route. It is proposed to utilize all the lakes, lagoons, and inlets along the shore in the construction of the proposed canal, which is planned to have a sufficient depth to float boats of all sizes and draught. The proposed route will be 30 miles shorter than the present open sea path. Should the enterprise be carried out, it will eventually be extended to the Rio Grande.

Lieut. Roche, of the United States Engineer Corps, who was in charge of the levee district below New Orleans, has been trying a plan of building levees with a hydraulic pump at a point sixty miles below the city. If the experiment is the complete success that is claimed for it, it would reduce the cost of levee construction to a minimum, and save the people of the lower Mississippi valley hundreds of thousands of dollars annually. The idea is not altogether new, but the difficulty was in holding the mixture of water and river mud thrown up on the shore by the dredge. This has finally been overcome by means of planking, which keeps the mixture within a limited territory. The planking leaked at first, but the use of willows stopped the leaks, and the experiment is now a success. The levees in Lieut. Roche's district are being built, not by manual labor, as all have heretofore been constructed, but by the mammoth steam dredge Ram. The old system was objectionable, not only because it cost a great deal, although it has fallen 75 per cent. in cost during the last ten years, but also because the levee, being made of dirt and not pounded down—this has been found impracticable—is not compact or solid enough, and yields readily to the pressure of the river. Lieut. Roche tried the system of building a levee by pumping the mud and water from the Mississippi, and now announces that it is a success. Levees can undoubtedly be built in this way, for there is the Plaquemines levee to show for it, and can be built more quickly. It is more solid and substantial than the levees built by hand, the soil being so compact that the crayfish, the bane of the Louisiana planters, cannot penetrate it, and this alone, Lieut. Roche thinks, will make the mud levees extremely popular. The matter of cost is not thoroughly satisfactory as yet. The new pump-built levee costs about the same as one constructed with scrapers or wheelbarrows, but this is attributed to the fact that the Ram was not intended for levee building, but for dredging. A much cheaper boat can be built which will do the levee work far more satisfactorily and will reduce the cost one-half. When this is done the levee-buiding machine will do all the levee work along the Mississippi, and get rid of the thousands of laborers and convicts who now do the work.

ELECTRICAL NOTES.

"Helle," the latest operatic success in Paris, was heard recently by electrophone in London, the sound being transmitted over the London-Paris telephone circuit.

The Council of the Society of Arts offer the Fothergill prize of £25 and a silver medal for a paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." The paper should consist of about 8,000 words and be written with a view to being read and discussed at an ordinary meeting of the society. Papers submitted for the prize must be sent to the secretary on or before October 1, 1896. Each paper must be type-written, and bear a motto, the name of the writer being inclosed in a sealed envelope with a similar motto.

At St. Ignatius' Church, in Hayes Street, San Francisco, about $30,000 has been spent in obtaining stained glass windows from Germany, and now it is found that it is no good, since at the evening service, which is the important one in most American churches, no one can see them. Owing to the construction of the church, their beauty was absolutely lost after dark. Consequently they have called in the aid of the electric light, and fixed arc lamps outside the windows. The congregation appeared to have liked the effect so much that the arrangement is to be a permanency, and the church authorities are now discussing the best arrangement of reflectors.

It is stated in L'Electricien that the Administration des Ponts et Chaussées of the French government have under consideration the establishment of a system of electric traction on the River Lot, which will take barges up as far as the Aveyron coalfields. Water power from the natural fall of the river is to be used to generate the current, and it is considered that the installation of some such system of barge traction is the only means of reviving the navigation of the river, which has greatly fallen off. On the other hand, as the Aveyron coalfields produce more than a million tons of coal a year, it is thought that it would be a matter of great importance to establish a convenient and cheap system of water communication between them and the district and port of Bordeaux.

Lord Armstrong has recently made some very curious photo-electrical experiments by means of a Wimshurst machine. This machine is caused to charge two large condensing jars, and the brush discharge from these latter, just before the tension rises sufficiently to produce an actual spark, is made to impinge upon a very sensitive gelatine plate. The operation is conducted in a dark room, and in the absence of either camera or lens, but the result on each plate employed is a most beautiful arborescent pattern, which is varied in each picture by modifying the conditions of the discharge. Very beautiful effects are also produced by using a simple plate of glass which, after being waxed, is covered witth a very delicate layer of fine dust; by the action of the discharge, this dust is made to assume various curious figures. It is well known that nature endows the lowliest organisms with most perfect form and intricate adornment, but it is curious to note that beauty of design should accompany even the phenomena connected with a discharge of electricity.

It appears that electricity is now to be used for the purpose of killing whales. A dynamo, with power-producing apparatus, is to be placed on a whaler, and not used until the whaling grounds are reached. On board there is to be placed a big reel of insulated wire, which is to be placed in a boat when a whale is sighted. One end of the wire is connected with the dynamo, and at the other end, which will be in the boat, will be a hard rubber stick, about four feet long. The wire is carried through the rubber stick, and is attached to a piece of metal twenty-four inches long and one inch in diameter. This metal rod is sharp at the end, so as to penetrate the flesh of the whale easily. The combined rubber and metal rods will be used just as a harpoon is now used, and when near the big fish the harpooner will throw the electric barb. At the time of striking there will be a current of 10,000 volts running through the wire. When the point of the needle strikes the whale, a current connection will be formed with the dynamo, the whale will get the full shock of the high voltage, and will be dead in the fraction of a second. At least this is the calculation of the enterprising captain of the whaler.—The above is from the Boston Journal of Commerce.

Various substances and mixtures have been proposed for replacing gutta percha as an insulating material for cables, says the Engineer, but although many of them are effectual in other particulars, none have so far rivaled it in point of durability under prolonged exposure to the action of sea water. Paraffin alone is too brittle, but the plastic products of the incorporation of ozokerite with small quantities of caoutchouc form a medium which in insulating power and durability almost rival the latter substance in its pure state. The degree of insulation attained by Henly's cable, which is coated externally with ozokerite, is 5,000 megohms per knot. Nigrite, prepared by kneading together caoutchouc and the residue from the distillation of ozokerite, is far superior, both mechanically and as an insulator, to gutta percha, and is less susceptible to heat than caoutchouc. The composition, consisting of a mixture of resin and heavy resin oils, used for the Brooks cable has a high insulating power, several samples having indicated regularly 19,000 meghoms per mile. Wray's composition, made from caoutchouc, silica, powdered alum, and gutta percha, is largely used in climates too hot for gutta percha by itself, but is quickly attacked by sea water. Latterly, attention has been directed to balata as a substitute for caoutchouc. This gum is obtained by tapping the balata tree, of which there are large forests in British Guiana and other parts of South America. There are two varieties—the red or "bullet tree," and the white, or true balata; they grow to a height of 90 ft. to 100 ft., and can yield about 2¼ lb. of gum in a year without overtaxing their strength. The liquid gum soon hardens on the surface, which is then removed, and this continued till the whole is solidified. For insulating purposes balata gum is, says the Journal Society Chemical Industry, inferior to caoutchouc, but it makes a good waterproofing material, and is highly suitable for driving belts.

MISCELLANEOUS NOTES.

England's oak is now made in Germany. The great roof beams of Winchester Cathedral are being renewed, and the wood used is Stettin oak, cut in 42½ foot lengths, the other dimensions being 14 by 18 inches.

In the United Kingdom, Germany, Belgium, and the United States, most, if not the whole, of the coal consumed is of native production. Of Russia's consumption, 79 per cent. is her own coal, 17 per cent. is British coal, and 4 per cent. comes from other countries. In Sweden 88 per cent. of the coal consumed is British, in France 12 per cent., in Spain 50 per cent., in Austria-Hungary less than 1 per cent., and in Italy nearly the whole is of British origin.

At the recent meeting of the National Association of Fire Engineers, at Montreal, was exhibited a complete suit of fireproof (asbestos) clothing. A fireman thus clad entered a burning wooden house, where he remained for several minutes, at the same time going through a performance calculated to illustrate life-saving and to exhibit the advantages of his dress. His hands were protected by asbestos gloves; his boots, of the same material, were soled with iron; and his asbestos helmet was glazed with mica, while a respirator in the crown permitted him to breathe the stifling air with impunity.

Those who now tolerate mice or rats in or about the house, says the Popular Science News, certainly must be blind to the fact that a luminous cat, which costs very little to secure and nothing to keep, has been invented, and can be placed in any dark corner or nook, and effectually scares away all such pests. This cat is struck or stamped from sheet metal, or other like material, so as to represent in appearance the exact counterpart of its animated feline sister. It is painted over with a luminous paint, so that it shines in the dark like a cat of flame. After being used for about a week the place is forever free of either mice or rats.

Game is to be preserved in Central Africa. Major von Wissman has set aside a portion of German East Africa, within which no shooting will be allowed without a license from the governor of the colony. A license to shoot elephant or rhinoceros costs 500 rupees a year for a native; females and young elephants with tusks weighing less than six pounds must not be shot at all. White men will pay 100 rupees for the first elephant shot and 250 rupees for every other, 50 rupees for the first two rhinoceroses, and 150 rupees for all after them. Monkeys, beasts of prey, boars, and birds, except ostriches and secretary birds, may be killed without a license.

The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or a prize of £30. The medal, under the conditions laid down by the testator, is to be given "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than December 31, 1896, to the secretary of the Society of Arts, Adelphi, London, W. C.

The first cotton spinning factory in Japan was erected in Satsuma by Prince Shimazu Narihisa. In 1850 he established a scientific laboratory in his grounds, and encouraged investigations in western medical and chemical sciences. He took a great interest in photography, telegraphy, glass making, and gas manufacture. Three years later he established a workshop near his summer villa, in which he made many experiments in machine and engine construction. He also erected at Niruso, a suburb of Kugoshima, a spinning factory, which still stands, and in which there are three thousand spindles in operation. The machinery was supplied by Platt Brothers, and was fitted up with all the best appliances of the time. The enterprise was started without any thought of profit making, and everything was done on an elaborate and expensive scale. An Englishman was engaged as superintendent. The yarns soon obtained a high reputation, and were employed in weaving the well-known cotton fabric of Kugoshima, Satsuma kasuri.

In giving an abstract of a report on the subject of the caking power of coals, by M. L. Campredon, the Journal of the Society of Chemical Industry says: "To determine the caking power of a coal, the sample is ground sufficiently fine to pass through a sieve of four hundred holes per square centimeter. It is then diluted with varying proportions of fine dry sand and the mixture ignited in a covered crucible, the character of the resulting coke being noted. The weight of the coal being taken as a unit, the largest amount of sand that the sample will bear and yet give a coherent coke represents the caking power of the coal. In the case of some Welsh coals, the coke takes the form of a powder without the addition of any diluent; therefore, the number found on examining different samples may vary from 0 to 17. It should be noted that mere exposure to the atmosphere affects this property of coal. At elevated temperatures the loss of caking power is still more rapid. There does not, however, seem to be any connection between the quantity of volatile matter in the sample and its caking power."

At the Industrial Exposition, at Zurich, Switzerland, there is exhibited an air tester which is designed to show whether and in what degree the air in a workshop or other inhabited room is contaminated. The apparatus is described as consisting of an airtight, closed glass vessel filled with a red fluid. Through a glass tube, that dips into the liquid and is bent at the top, a drop falls every one hundred seconds on a cord that hangs beneath and that is somewhat stretched by a weight. The fluid from which the drop comes has the property of changing its color by the action of carbonic acid. The more carbonic acid there is in the air, the quicker this change in color takes place. If the air is very foul, the drop becomes white at the upper end of the cord, while the change of color, corresponding to a slight proportion of carbonic acid, does not take place till the drop has run further along the cord. The exact condition of the air can be ascertained by observing a scale that is placed alongside the cord and divided into convenient parts, bearing the designations, "extremely bad," "very bad," "passable," "pure."

THE FIFTIETH ANNIVERSARY NUMBER OF THE SCIENTIFIC AMERICAN.

WE call the attention of those of our readers who may not be subscribers to the SCIENTIFIC AMERICAN to the fact that to-day we are issuing a very handsome special number, to commemorate the fiftieth anniversary of the foundation of that publication.

As the SCIENTIFIC AMERICAN has devoted itself to the faithful chronicling, week by week, of the growth of science and invention, it was thought fitting to make the special number consist of a review of the scientific and industrial progress of the United States during the past fifty years. No effort has been spared to make this number as comprehensive as its title implies, and the best scientific and technical writers of the day have contributed to make the 72 pages of the issue one of the best compendiums of historical reading matter that have been put before the public.

It is freely illustrated with carefully selected engravings, many of which are of great historic interest; and it is inclosed for preservation in a handsome cover, which was specially designed for this issue.

In addition to the comprehensive list of subjects which form the subject of review, the number contains the full text of the successful essay in our anniversary prize competition, on the subject of "The Progress of Invention During the Past Fifty Years," which secured to the writer the prize of $250.

We would also add that the number closes with an illustrated history of the SCIENTIFIC AMERICAN, which we venture to believe will prove to be not the least interesting feature of the paper.

The special edition can be obtained at the price of ten cents, either by application to this office or through any newsdealer. See announcement on page 17158.

THAMES PADDLE STEAMER SOUTHEND BELLE.

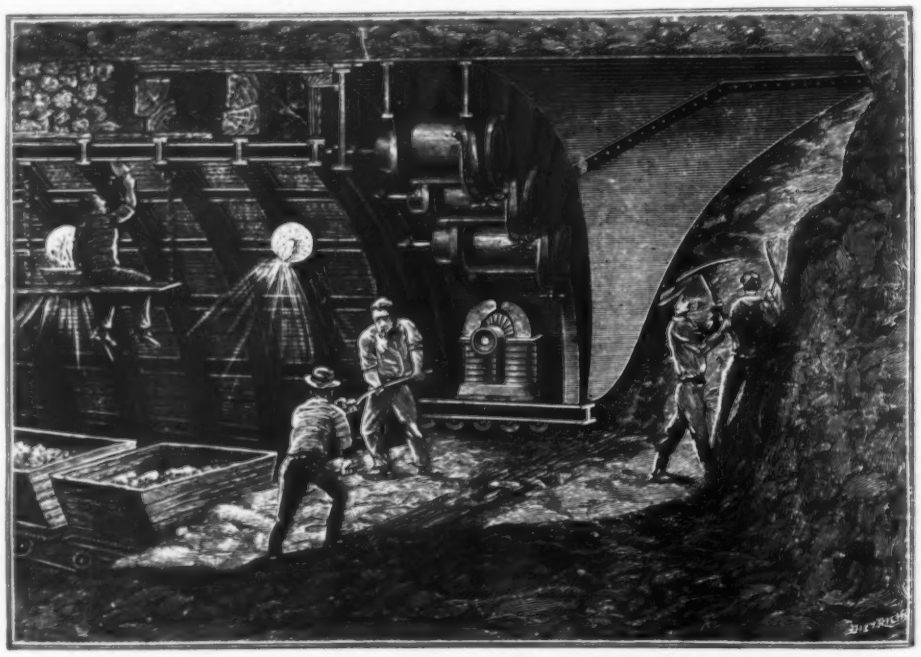
THE Southend Belle is a saloon steamer with a long promenade deck, her principal dimensions being 249 ft. by 30 ft. by 10¼ ft., and she has accommodation for about 2,000 passengers. The first class passengers' saloon is at the after part of the upper deck, and it is fitted up in the most artistic and luxurious manner. Just on the fore side of the first class saloon are the ladies' boudoir and two private cabins, while forward of these are the vestibule and stairway to the lower or dining saloons.

The first class dining saloons are two in number, and can seat 120 passengers at once. They are situated on the lower deck, and are reached by a large stairway from the upper deck.

The Southend Belle is fitted with direct acting triple expansion diagonal paddle engines, illustrated herewith, having cylinders 28 in., 41¼ in., and 60 in., with a length of stroke of 5 ft. The valve gear is upon the fixed quadrant principle, as designed by Mr. W. Brock, the valves being on the top of the cylinders, thereby reducing the athwartship space occupied, and bringing the gearing within convenient reach of the engineer. Piston valves are fitted to the high pressure and intermediate cylinders, and a flat slide valve with balance rings to the low pressure. The entablatures of the engines are of cast steel, and stayed at the top with a cast steel tube carrying the valve motion quadrants, which are also of cast steel. The centrifugal circulating pumps are by Messrs. Drysdale, of Glasgow. The air pump is worked off the main engine, as also are the sanitary and bilge pumps. The air pump discharges the water into a tank from which it is pumped to the boilers by a pair of Weir's direct acting pumping engines, each of which is sufficient to feed the boilers when the vessel is developing full power. One of Edmiston's feed filters is fitted on the main feed pipe range, and is found to act very efficiently in preventing the passage of grease or oil from the engines to the boilers. It may also be noted that in the main lubrication of the engines oil is not used, there being fitted a complete installation of the Axiom automatic lubricating gear, which is also found to be both efficient and economical, besides keeping the engine room clean and free from the unpleasant smell of heated oil.

Steam is supplied to the engines from two boilers of the Navy type, having in all six furnaces, and working at a pressure of 160 lb. per square inch. They are worked upon the closed stokehold principle, and air is supplied to them by a large fan driven by a Chandler silent inclosed engine, which, along with the steering gear, stands upon the deck over the boilers. The joints to the pipes exposed to high pressure are made by means of Pope's patent flanges, and the main steam pipes are hooped with steel bands on Mr. Peter Denny's system, to strengthen them against the risk of bursting.

Upon her trial runs on the Clyde the Southend Belle attained a mean speed of 21¼ miles per hour. She is intended for the further development of the company's passenger service to Southend, Clacton, Felixstowe, Harwich, and Ipswich. Her construction was superintended by the company's engineer, Mr. Dugald Brown, and she was fitted out under the supervision of her commander, Captain Holland. We are indebted to the London Engineer for the cut and particulars.



CONSTRUCTION OF THE NEW CLICHY COLLECTING SEWER AT PARIS.

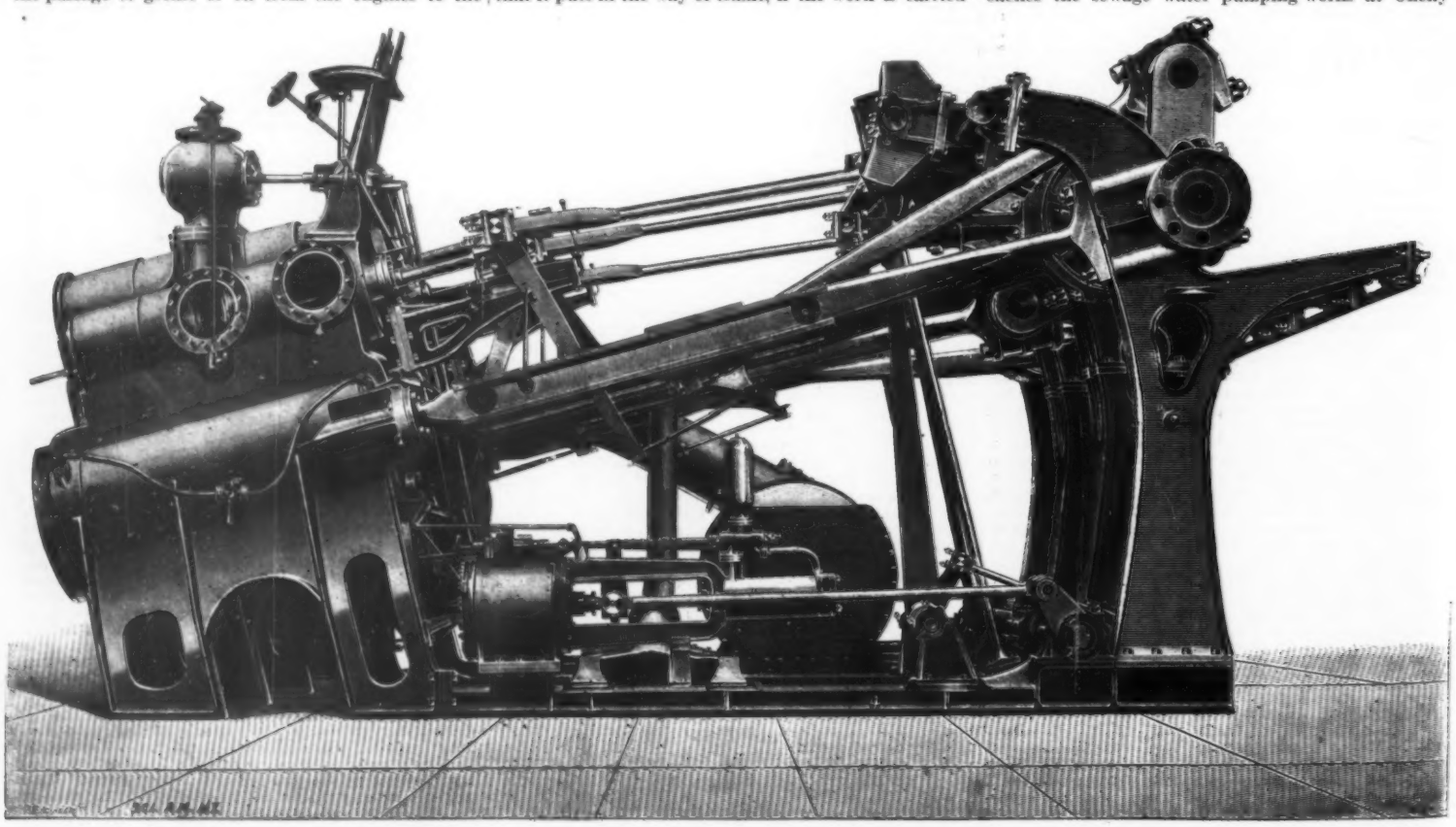
CONSTRUCTION OF THE NEW CLICHY COLLECTING SEWER.

THE construction of a tunnel under the streets of a large city is always a difficult operation, and a particularly troublesome one, on account of the obstacles that it puts in the way of traffic, if the work is carried on by making an open cutting. The streets are torn up, and the removing of the spoil occupies those parts of the thoroughfare that remain disposable, and which the deposit and accumulation of supplies tend, moreover, to obstruct. The method by galleries, which is usually employed for railway or mine tunnels, is too costly, since, in the soil of a city, which has been disturbed to some depth, which is without consistency, and is exposed to lateral pressure determined by the structures at the sides of the street, would necessitate timbering of considerable amount, and, besides, the execution of the headway would, for the same reason, be attended with real danger.

The majority of such difficulties attending the subterranean method disappear with the use of the shield, which, at the same time, permits of preserving all its general advantages.

Devised by the late Mr. Alfred E. Beach, one of the proprietors of the SCIENTIFIC AMERICAN, and taken up in 1887 by Mr. Greathead for the construction of the electric railway tunnel under the Thames, and by Mr. Berlier for the construction of the Clichy siphons and the Concord bridge, the shield process has just received a very interesting application in the construction of the Clichy collecting sewer. Mr. Chagnaud, the highest bidder for this work, has even established a shield that permits of the construction of masonry, while the tunnels or siphons constructed by Messrs. Greathead and Berlier are lined with cast iron tubes, whose sections, provided with internal flanges, are assembled by means of bolts. The substitution of masonry for cast iron effects a saving of more than one-half per running foot.

The new collector starts from Place de la Trinité and reaches the sewage water pumping works at Clichy



TRIPLE EXPANSION PADDLE ENGINES OF THE SOUTHEND BELLE.

through Clichy Street and Avenue in Paris, and the National Boulevard outside of the city. It has a total length of about two and a half miles, with a uniform gradient of forty inches to the mile. Its transverse profile admits of two different types according to the work to be executed: Between Place de la Trinité and Clichy Place, the internal section is a semi-circumference of 8 feet radius connected with the banquets by arcs of 6 feet radius. Each of the banquets has a width of 3 feet, and the drain trench a width of 9·8 feet for a depth of 6½. The other type, which prevails for the remainder of the length, has an internal section composed of an ellipse, whose long horizontal axis is 19·6 feet and whose pitch is 8. The banquets have the same width as in the other type, but the drain trench is 13 feet in width for the same depth of 6½ feet.

The new collector is designed to receive the discharge of the principal affluents of the present Asnieres collector, especially of what is called the Coteaux collector coming from Saint Mandé, of that of Provence starting from Montmartre Street, and that of Center, which has its origin at the Bastille.

It will be able to discharge 350 cubic feet per second, that is to say, the total volume furnished by the Asnieres and Marceau Avenue collectors, so as to assure the prompt removal of the supplement of waste water that will be produced at the time of the complete application of the "tout à l'egout."

The transverse profiles of the types above mentioned have a superficies of 293 and 375 square feet respectively in the clear. This, at least for the last, is nearly the same section as that of the tubular tramway projected by Mr. Berlier, and would suffice for the installation of two lines of 3·28 feet gage. The difficulties that would have been experienced had it been necessary to construct so extensive works in Paris and the suburbs by the ordinary processes will be readily seen. Moreover, an idea thereof may be obtained from the obstacles of all kinds that for two years accompanied the establishment of the tunnel that extends from the Sceaux station to Medico Place.

On another hand, somewhat serious difficulties were met with in the use of the shield for the crossing of the National Boulevard at Clichy, where the thickness of the natural ground above the projected vault is 10 feet at a maximum, and for the greater part of the length, between 4 feet and 75 inches. Besides, since the axis of the work is situated near the right side of the boulevard (in going toward Paris), the loads determined by the large trucks that come from Gennevilliers are exerted entirely upon the left side only of the shield. It was therefore necessary to construct it under conditions of exceptional solidity.

The apparatus used for this construction is therefore very peculiar. The shield properly so called consists of two principal centerings of plate and angle iron between which are fixed six hydraulic cylinders 10 inches in diameter and of 3 feet effective stroke. These cylinders take water from one pipe in common. The piston rods are held by nuts and jam nuts in a stationary beam so that they can undergo no motion.

They bear against the centerings that serve to hold the bolsters against the earth in order to prevent cavings in, and then to give the support necessary for the construction of the masonry. These centerings have, as external perimeter, that of the intrados of the vault, so as to leave the thickness of the masonry free, while the principal centerings in front have the same perimeter as the extrados. They are carried by longitudinals which move upon cast iron rollers resting upon wooden beams. As for the centerings designed for the execution of the masonry, they are fixed upon the ground, so that the removal of the centering may be proceeded with as soon as the mortar has set.

Mr. Chagnaud makes considerable use of electricity in his plant, which is perfectly organized in every respect. A generating dynamo established in the vicinity and actuated by two movable engines of 25 h. p. each furnishes the energy necessary for the lighting and ventilation of the tunnel and the moving forward of the shield. The receiving dynamos and the compression pumps are, to this effect, concentrated upon the left of the apparatus. To the right is placed the water tank for the supply of the hydraulic cylinders.

After the workmen, under the protection of the hood that precedes the shield, have cleared away the earth in front for a length of three feet, the work is stopped. The pumps are then set in motion, and as the rods of the pistons are stationary, it is the cylinders that advance and carry the shield with them. Advantage is taken of such advance to take down the last of the centerings and to remount it in the free space that the shield has just left behind it. The progression is three feet at each operation. The workmen in front attack the earth (which consists especially of a dry crumbling sand) with picks, while others load the spoil upon cars that run upon a two-foot track that extends to the first centerings. This track likewise serves for the carriage of the materials for constructing the vault.

The contractor has even installed under the front hood a small endless belt carrier actuated by a small receiving dynamo. This carrier has permitted of entirely suppressing the stoppages that would have occurred in the interim of loading the spoil upon the cars. Mr. Chagnaud's shield is, as may be seen, truncated according to the line that unites the two edges of the drain trench. This incomplete form shows that an application of the system might be made without much difficulty in railway work or in mine galleries whose profile is analogous.

A progression of 26 feet per 24 hours of continuous work is reckoned upon at Clichy. It has been possible, nevertheless, to obtain a maximum advance of 29½ feet. The masonry work of the vault follows very closely upon the removal of the spoil, and every section is wedged up forty-eight hours at the most after the excavation. The centering is struck at the end of three days only, and despite this short delay the vaults show no sign of settling. The proportion of Portland cement is 22 pounds to the cubic foot of sand.

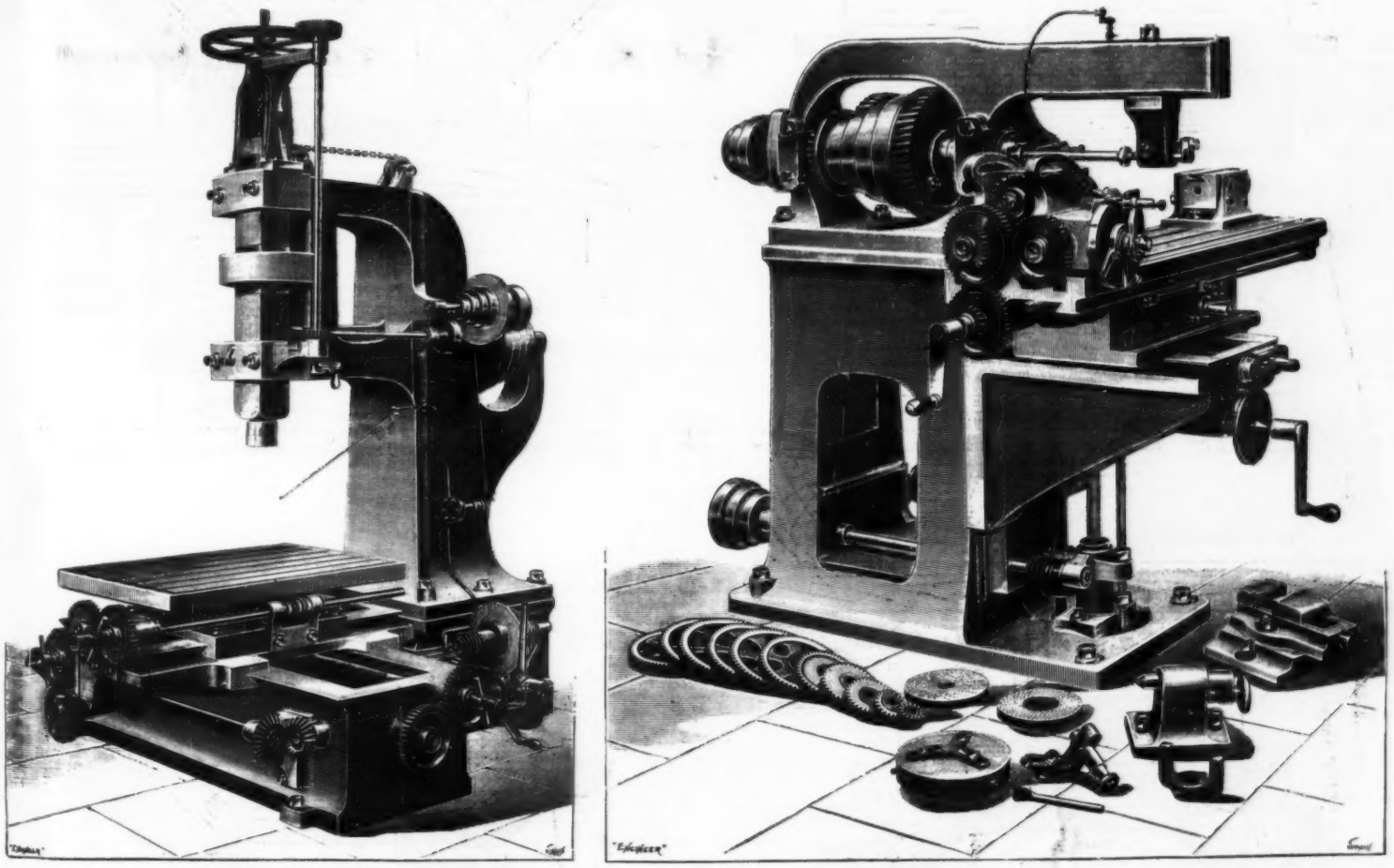
As for the drain trench, that will be executed by excavation and pumping, as soon as the vault is finished and allows of the work being done completely under shelter. Mr. Chagnaud's enterprise ends at the gate of Clichy, and will be pursued for a total length of 5,740 feet. Beyond, and under the streets of Paris that we have already mentioned, the construction of the Clichy collector has been awarded to the Fougerolle Brothers. The process employed will be identical as to principle, that is to say, the shield alone will be used, so as to reduce to a minimum the annoyances to which those living in the vicinity might be subjected. But, in this part, the shield will have to embrace the entire front of the cutting by reason of the depth at which the tunnel will be excavated, and in order to more easily resist the pressure of the surrounding earth.

The work on the Clichy collector, despite its importance, does not, as may be seen, interfere with the traffic of the streets whose subsoil it utilizes. There is here an object lesson that ought not to be lost sight of by our engineers and builders, since it demonstrates the practical possibility of constructing, without inconvenience of any kind, masonry tunnels of wide section like those that would be required by the metropolitan railway.

For the above description and the engraving, we are indebted to La Nature.

HORIZONTAL AND VERTICAL MILLING MACHINES.

THE universal horizontal milling machine illustrated herewith will, in addition to all the ordinary forms of straight milling of which these machines are capable, form the teeth of milling cutters, wheels, reamers, etc., and the flutes of twist drills, taps, and other useful workshop tools. It is a strong and very powerful machine, especially suitable for marine engineering work, and will mill flat surfaces up to 6 in. or 8 in. wide and 2 ft. 6 in. long, and when working, a cutter 4 in. diameter will admit a maximum depth between it and the table of 14 in. Cuts may be taken exceeding ½ in. in depth, and the speeds of the "feed" traverse are graduated from under ½ in. per minute to a rate exceeding 2 in. The fast headstock has double gearing—the wheels being all machine cut—and a four-speed cone pulley, the steps being respectively 13 in., 11 in., 9 in. and 7 in. diameter and 3 in. wide. The overhanging arm carrying the outer support for the cutter arbor is cast in one with the headstock, thereby affording great rigidity. The main spindle is of steel, 3 in. diameter, carried in hard gun metal adjustable bearings, so arranged that the "cutting" thrust is against the solid metal. The feed mechanism is carried directly through the center, around which the table swivels, and serves without alteration for all the varying positions—vertically, angularly, or horizontally—in which the table may be placed. The accessories provided with the machine, which form a very complete set, are clearly shown in the engraving, and are accompanied by a printed tabular form setting forth at a glance the various angular positions and divisions required for the multiplicity of work this truly "universal" machine is destined to cope with.



VERTICAL AND HORIZONTAL MILLING MACHINES.

Our other illustration shows a patent self-acting vertical milling and profiling machine, used chiefly for edge milling, but it is also very efficient for machining flat surfaces. The latter are operated upon by means of "face" cutters, which are made with inserted teeth, when dealing with large surfaces, and are specially applicable for marine engineering work. The machine is very rigidly constructed, with a hollow frame of the slotting machine type, as shown in the illustration, which is taken from a machine measuring 2 ft. 2 in. from the center of the spindle to the frame, and 1 ft. 9 in. from spindle nose to table top—maximum. The spindle is of steel with conical bearings having a diameter of 3½ in. at the main neck, and it runs within a 6½ in. square bar forming a vertical slide, and rising and falling with it, so as to keep the bearing always close to its work, and give great solidity of action. This bar has a vertical motion of 12 in., and is balanced. The table is rectangular, measuring 3 ft. 6 in. by 2 ft. 3 in., with the grooves for securing work, and a trough all round for collecting the lubricant. It is provided with variable self-acting motions, longitudinally, transversely, and circularly, all being reversible, and the circular motion can be readily disengaged to facilitate the rapid concentric setting of the work on the table. When profiling, the longitudinal table slide is disengaged from the screw, and the "former" or model is fixed on the table, directly underneath or alongside the object to be formed, and is held against an adjustable roller,

carried by a swinging bracket attached to the main frame of the machine. This attachment is not shown in the illustration. The traverse of the table is 2 ft. longitudinally and 3 ft. transversely. The rates of feed traverse range from about ½ in. per minute to over 2 in., and cutters up to 8 in. or 10 in. in length may be used, in such cases a special support being arranged for the cutter arbor at its lower extremity. A centrifugal pump and the requisite fittings for lubrication are provided, the supply being drawn from a suitable tank formed in the frame of the machine. The driving motions are transmitted from a cone pulley with ample belt surface, through powerful gearing, the teeth of which are all machine cut, and without the intervention of any sliding keys. We are indebted to London Engineer for the cuts and copy.

NOTES ON CONVEYING-BELTS AND THEIR USE.*

By THOMAS ROBINS, Jr., New York City.

ABOUT six years ago the writer had occasion to visit a large magnetic iron ore concentrating plant, and then saw for the first time rubber belts being used for conveying purposes. These belts were from twenty inches to thirty inches in width, and some of them were as long as five hundred feet between centers. When I spoke of the enormous amount of material they handled with a small expenditure of power, the superintendent assented, but at the same time complained that although he bought the best quality of belts, the abrasion of the ore wore them out very rapidly, causing continually very large bills for repairs and renewals.

On close examination several interesting points were discovered:

1. It was noticed that the thin layer of rubber which covered the belt resisted the abrasion much longer than did a corresponding thickness of the cotton duck which formed the body of the belt; in fact, the life of the cover represented about one-half the life of the belt, although forming less than one-fifth of the total thickness.

2. Each layer or ply of duck wore out more quickly than the one preceding it, showing that the fibers were cut more easily when under tension, and, of course, the tension on each fiber increased as the number of fibers bearing the tensile strain diminished.

3. The wear was greatest in a line along the center of the belt. Frequently this part would be so quickly destroyed as to cause the belt to split in two longitudinally, though at the same time the portion nearer the edges was almost as good as new.

Noticing these facts, it became obvious that the functions of the cotton duck should be solely to give the belt tensile strength, and that it ought to be so protected by some abrasion-resisting cover that it would not be injured by contact with the material conveyed. It is also evident that this protecting cover ought to be of extra thickness over the center of the belt, in order to stand the harder work forced upon that part. Being engaged then, as now, in rubber manufacture, it was a simple matter to make a belt with a heavy rubber cover on the carrying side and thicker in the center than at the edges.

This reinforced cover renders the resistance to wear equal in all parts of the belt, and although being merely the anticipation of a patch, like the brass toe cap on the schoolboy's shoe or the two-ply seat in his trousers, it was, like them, deemed patentable.

The ideal conveying-belt would be like the celebrated "one hoss shay," which disintegrated so evenly and completely when its work was done that there was nothing left to repair or regret.

Wishing to ascertain what particular compound of rubber would make the most durable carrying surface, I made a lot of small samples, each mixed differently, and exposed them to a very powerful sand blast, which in its effect approximated the conditions to which the compound would be subjected in actual use, but it was more convenient for a large number of tests, being much quicker. The result of the first series of experiments indicated what grades of gum and what adulterants had better be left out, and also showed something that was very gratifying, namely, that there were certain adulterants which could be used in sufficient quantities to bring the cost down to a reasonable figure. I then made a second set of samples, following in the mixture the formula used in the more successful ones of the first set, but each new one was an attempt to improve upon its prototype. Some of the samples, owing to more intelligent methods in mixing them, proved so durable that the sand blast test became too tedious, and a more severe and expeditious one was needed. This was found in exposing a disk of the rubber six inches in diameter by one eighth of an inch thick to a heavy falling stream of crushed ore. The ore averaged about three-quarters of an inch in size, and was delivered in a compact and heavy stream from the end of a very fast moving belt. The sample was so fastened to a board as to receive the whole stream of ore and immediately deflect it. In this way the rubber came in contact with two hundred tons of ore per hour, of which each fragment was delivered with considerable force full upon it. At first it was easy to see the comparative loss of weight after the sample had been exposed to the ore for an hour or two. In the next series results were very apparent after a day's run, but later, as results were developed which I was willing to accept as final, it became necessary to weigh each disk before and after the exposure, and thus learn the percentage of loss. The figures relating to the last set of compounds are as follows:

Samples.	Weight Before Test, in Grammes.	Weight After Test.	Percentage of Loss.
No. 154	103·0	102·7	0·0029
" 155	140·0	138·9	0·0078
" 156	134·7	132·0	0·0164
" 157	116·7	113·8	0·0257

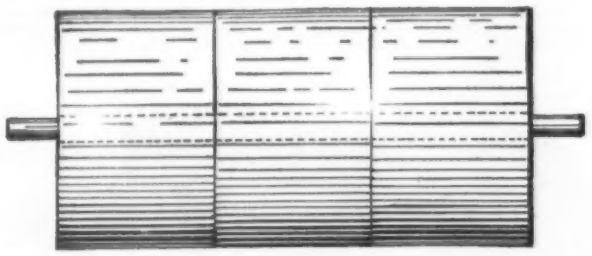
This test lasted for 12 hours' steady running under the conditions stated above.

Having at last decided upon the proper compound for the carrying surface, I applied it to the belts, and I may say that every belt made since that time, which was in 1892, is in good order to-day. In many cases, too, the belts which they replaced had been completely destroyed in three months' time under exactly similar conditions.

There are four principal methods of supporting conveying belts.

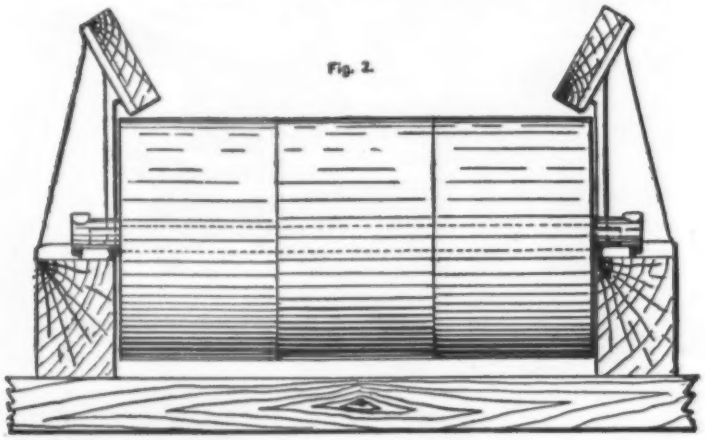
First we will consider the oldest method, in which the belt lies flat upon a straight faced, horizontal pulley, as shown in cross section, Fig. 1. On account of the liability of the material to roll off the belt, this form is only suitable under certain conditions. The belt cannot be heavily loaded, and the feed must be so regulated that an even amount may be delivered to the belt at all times. If the material is below ¼ inch in size, the speed may be as high as 300 feet per minute. In carrying larger stuff on flat belts the speed must be lower; but the most necessary thing is to keep the belt very tight, that the material may not be jarred off in passing over the idler pulleys. This, of course, increases the strain on the bearings, and from that fact, together with their low efficiency compared with systems to be described later, we may consider flat running belts as being out of date.

Fig. 1.



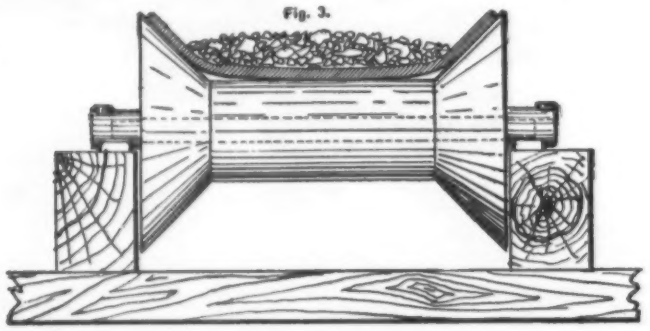
OLDEST METHOD OF SUPPORTING CONVEYING BELTS.

Fig. 2.



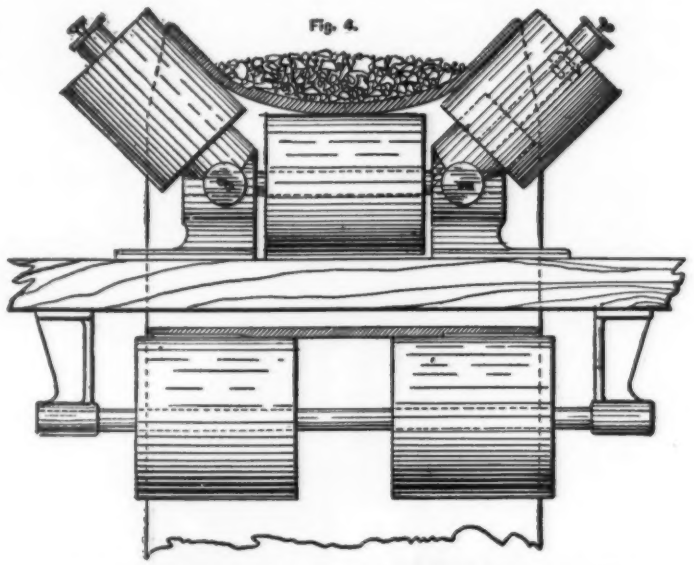
IDLER PULLEYS WITH SKIRT BOARDS ADDED.

Fig. 3.



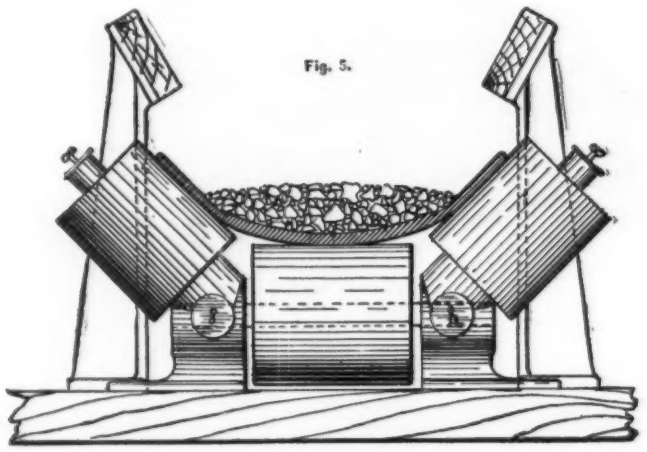
CONICAL SIDE IDLERS.

Fig. 4.



BEST METHOD OF SUPPORTING CONVEYING BELTS.

Fig. 5.



BEST METHOD OF SUPPORTING BELTS WITH SKIRT BOARDS.

The second method (Fig. 2) is somewhat like the first, but with the addition of skirt boards at the sides to increase the capacity of the conveyer.

This method of rigging belt conveyers is in great vogue among brick makers and others who handle clay. It will be easily seen that the material must collect between the skirt boards and the belt, and that, as it hardens, it will cut a strip off each side. The common practice is to start with a wide belt, and move the skirt boards in as fast as these strips are cut off. When the width is so reduced as to render the conveyer totally useless, wheelbarrows are called into play until a new belt can be procured, and the entire process recommenced. This method is so entirely bad, that I refrain from further description. It is only fair to say, however, that the skirt boards fill one useful purpose, as it is the practice of the men shoveling into the belt to rap their shovels against the boards in order to get

* At the Pittsburg meeting, February, 1896, and published in the Transactions of the American Institute of Mining Engineers.

rid of the sticky clay. A board for this purpose can be applied, however, to a much better form of conveyer, and in such a way that it cannot interfere with the belt. (See Fig. 5.)

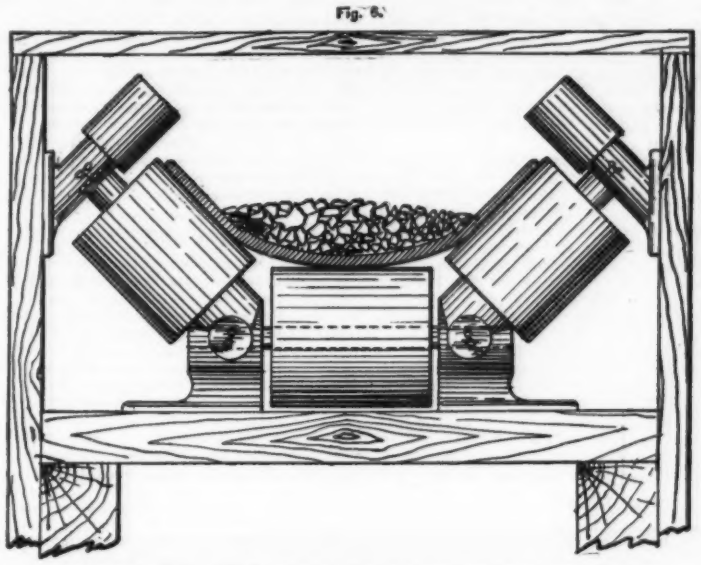
The third method is a slight improvement upon the last, in that a trough is made by raising the sides of the belt instead of using boards as described above. The conical pulleys used for this purpose are shown in Fig. 3.

This method has an obvious fault, owing to its bad design. By reason of the difference between the two diameters, the outer edge of the pulley goes twice as fast as the inner edge. This causes a slip which soon wears out the under surface of the belt. For belts not wider than 14 inches this form is not bad, for, with small belts, the weight on the pulleys is light, and the effect of the slipping is consequently less severe.

There has been no mention hitherto of the means of supporting the empty part of the belt on its return. This is done by a single flat pulley of the kind shown in Fig. 1, or with a pair of smaller pulleys with an interval between them, as shown in the lower part of Fig. 4.

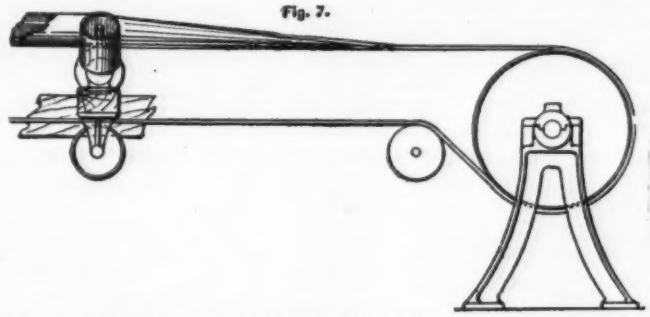
It is sometimes possible to save money in constructing a long conveyor by combining the first and last methods of belt support referred to. If the belt were run flat the whole distance, it would need to be so wide that the extra cost of the belt would be about equal to the money saved in using the cheaper flat form of pulley; but by placing a set of troughing pulleys between every fourth and fifth set of flat pulleys, or at such other interval as may be found advisable, the load is so centered on the belt at each of these points that it has no time to overflow before it is again centered between the next pair. In this way the use of a very wide belt is unnecessary, but the conditions are not always favorable to this plan.

Fig. 6.



METHOD OF FIG. 4, WITH GUIDE PULLEYS ADDED.

Fig. 7.



SIDE VIEW, SHOWING THE PROPER POSITION FOR THE FIRST RETURN IDLER, IN ORDER TO GAIN LARGE ARC OF CONTACT.

The fourth, and best form of belt support, is composed of three pulleys, one carrying the middle or bottom of the belt, and one on each side with its axis at an angle of about 45°. The shafts of all three pulleys are held in a pair of combination bearings which can be adjusted to different widths of belt. I never supply any other form of support for belts wider than 14 inches, and when I refer to troughed belts in this paper, it is to be understood that the sides are raised by means of these angle pulleys, one common form of which is shown in Fig. 4.

On some conveyers, it is often advisable to have at intervals a pair of idlers, running on a vertical axis, or inclined inward, so as to make a right angle with the edge of the belt. These will serve to keep the belt straight on the pulleys if there is any tendency to run toward one side. (See Fig. 6.)

The large pulleys at the end of the belt should be slightly crowned on the face, and the pulleys should be not less than 4 inches wider than the belt. The driving pulley ought never to be less than 30 inches in diameter, and in the case of long wide belts 48 inches is advisable, as it allows the first return pulley to be so placed as to give the belt a very large arc of contact on the driving pulley. (See Fig. 7.)

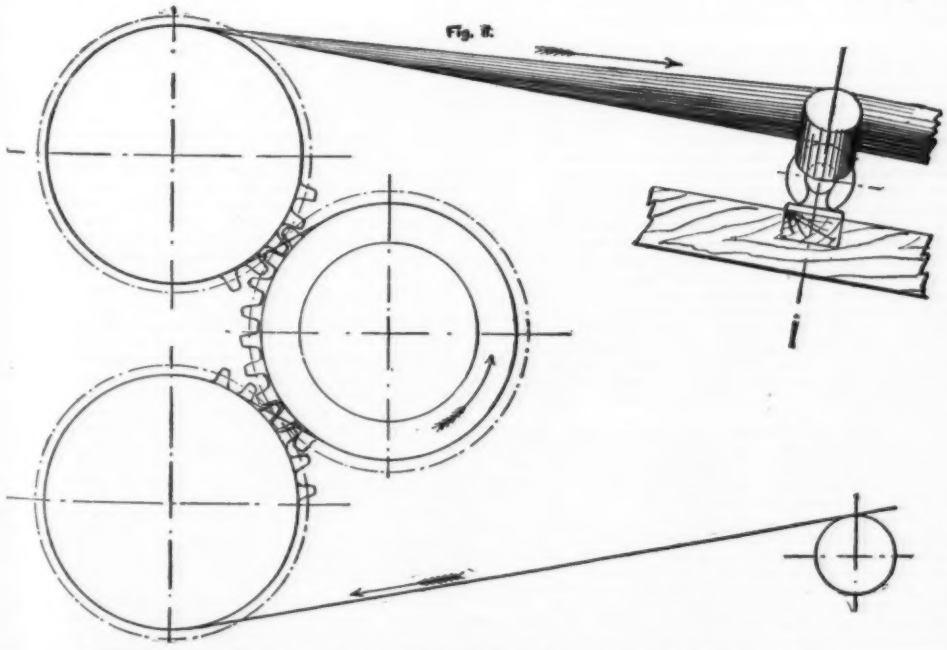
Whenever it is possible, it is better to have the driving pulley at the delivering end of the belt; but if it must be at the receiving end, a triple set of pulleys connected by gears can be easily arranged which renders slipping impossible with the longest and heaviest loads. I believe that this scheme was first used by Mr. S. H. Edwards, superintendent of the Magnetic Iron Ore Company at Benson Mines, New York. (See Fig. 8.)

The proper distance between the sets of idler pulleys is an important factor in the economical running of the belt, as will be referred to later. I believe that the troughing pulleys should be from 4 to 6 feet apart, according to the weight of the load, and that for the return belt there should be pulleys placed under every alternate set of troughing pulleys, which would make the lower pulleys from 8 to 12 feet apart.

To me, one of the most wonderful things in connection with this subject is the exceedingly small amount of power required to move enormous quantities of material. The power required, in one case, to run a conveyor, which carries 1,000 tons per day a distance of 180 feet, and elevates it 40 feet while doing so, is all transmitted by a torn and frayed little 5 inch belt, which takes its power from a pulley on the shaft, and transmits it to a pulley alongside the head pulley of the belt. The power is here divided, part of it going over a sprocket chain to help drive a large dumping apparatus. Yet the entire amount of power employed for both purposes does not exceed four horse power.

(To be continued.)

Fig. 8.



METHOD OF DRIVING LONG CONVEYERS FROM THE RECEIVING END.

ARMIES OF THE WORLD.

THERE is a treasure of condensed information in the "Notes on Organization, Armament, and Military Progress" just issued by the Military Information Division of the Adjutant-General's Office at Washington. The work is most creditable to its compilers, says the New York Sun, and is of public as well as professional interest.

In glancing along the list of countries reviewed, the eye naturally rests, at this time, upon Spain. To this country is ascribed a population of 17,560,000 with an army strength proper, in rank and file alone, of 84,000 for the year 1895-96. But this last does not include the "guardia civil," or gendarmerie, or the colonial forces; and according to the army list for January of this year, the rank and file, including the guardia civil, etc., numbered 113,551; the first reserve, all trained, 63,212; the second reserve, of whom a little over one-third have had military instruction, 548,234. This would give an aggregate of 724,997 trained and untrained, taking the army and its reserves. But an estimate by a "foreign staff officer" is added which puts the total of trained men at 415,675, including both reserves, with about 175,000 for untrained men, "condicionales."

In any case, it appears that the first reserve has been heavily drawn on for Cuba, because the notes say that "over 100,000 men" were sent thither in 1895-96, and presumably the permanent forces were not absolutely derived from the peninsula. The normal strength of the permanent army in the island is put at 981 officers and 19,199 men, but volunteers and militia are said to have increased the total strength to 59,000, apart from the heavy forces sent from Spain. Finally, the total "army of operations" in Cuba on Dec. 1, 1895, is put at 92,413, while about March 1, 1896, including perhaps 20,000 sent thither Feb. 12 preceding, it was about 118,730. It is added that four or five per cent. may be deducted for losses.

Taking other countries alphabetically, the Austro-Hungarian army is found to have a grand total of 349,000 officers and men on its peace footing, while its war budget for 1895-96 was $56,100,000. Little Belgium's budget for 1895 was $9,115,322, while her available peace strength at a recent date was estimated at 3,505 officers and 48,648 men, with a militia of 43,359 men. England, including India, showed recently 368,846 effectives of all ranks, while army reserves and militia brought the establishment for 1895-96 up to 865,421, with effectives amounting to 816,853. Her annual military budget is put in round numbers at $89,000,000.

The war expenditure of France for 1895 is put at $123,090,000, and the total net effectives of her active army at 524,768. Germany, according to this authority, has the still heavier peace strength of 584,734 officers and men of all grades. Then comes a great drop to Holland's home army of 21,500 men. However, the Netherlands also possesses two colonial armies, the East Indian and the West Indian, the former of which numbers about 1,400 officers and 34,000 men. The war budget amounts in round numbers to $9,132,000. The average effective peace footing of Italy, as limited by the budget for the year ending June 30, 1895, was 222,275 of all ranks, counting employes. The full organic strength, however, was about 276,000. Russia heads the list of enormous military establishments with a peace footing of about 880,000 of all ranks, to which may be added 30,000 frontier guards. Her budget for 1896 amounts to nearly $230,000,000.

Switzerland furnishes an example of a different, yet effective system. This small republic, whose constitution prohibits a standing army, adopts a militia system pure and simple, but carries its military training as far as that of some standing armies. From the age of ten until they leave the primary schools all boys receive gymnastic instruction, which includes drill in the manual of arms. Then further gymnastic instruction is given, until their twentieth year, and there are also voluntary cadet corps of schoolboys. Of the regular military service first comes the elite, lasting from the completed twentieth through the thirty-second year; then the landwehr, through the forty-fourth year; finally the landsturm, through the fiftieth year it also including youths between seventeen and twenty years of age. Last year there were 137,649 in the elite, 80,602 in the landwehr, and 270,363 in the landsturm, of whom, however, only 61,224 were armed. This establishment was kept up on a budget which for 1895-96 carried 22,769,529 francs.

Turning to countries on this side of the water, we find that our neighbor, Mexico, has a regular army of about 23,000 officers and men, including the national guard and some auxiliaries and employes. The recruiting is

done partly by voluntary enlistment, partly by conscription in the states and partly by sentencing criminals to army service. The budget for 1895-96 appropriated $9,130,649.08, reckoned in Mexican dollars. Colombia's peace establishment was formerly about 5,000 men, but it is said that this force has since probably been doubled. The soldiers are all Indians recruited by impressment.

The notes on small arms form a valuable part of this work. One table, obviously compiled with great care from official data, gives the weights and dimensions of the various infantry weapons. It shows in general that the smaller states, which have but recently rearmed their troops, have very generally taken to decreased calibers. Thus Mexico, Brazil, and Chile have the 0·276 Mauser, Holland, Sweden and Roumania the Mannlicher, 0·256, Norway the Krag-Jorgensen 0·256. This last is interesting, as we have the Krag-Jorgensen, 0·30, for our army. Spain has the 0·276 Mauser, and Italy the 0·256 Parravicino-Carcano. The smallest caliber is in our navy, 0·236 Lee.

It is suggested that, should these small calibers show their superiority, countries like Germany, France and Russia will have to rearm with them in spite of the cost. But voices from various quarters are heard against further reduction. China in her last war used mostly Hotchkiss 0·45 magazine rifles, made by the Winchester Arms Company; but there were various other rifles employed, besides old time wall pieces, petronels, tridents and arrows. Japan had her 0·315 Murata magazine rifle, but it seems that up to March 1, 1895, the single loader 0·433 was in use.

The countries of South America have shown themselves alive to modern small arms, and statistics are given to show that Brazil, Chile, and Argentina are far better provided with them than the United States. One Berlin company has delivered to Argentina 150,000 Mauser rifles, and 10,000 carbines, while Krupp has delivered 300 field pieces. Brazil has 145,000 small caliber rifles, 5,000 carbines, and 300 Krupp field pieces. Chile has, or will soon have, it is thought, 120,000 Mauser rifles, 10,000 carbines, and 200 field guns.

Our northern neighbor, Canada, has purchased of the British War Office 40,000 Lee-Enfield magazine rifles and 2,300 carbines, 24 12-pounder guns, 50 Maxim guns, with 5,500,000 rounds for the latter and 18,000,000 of rifle ammunition, and so on. The cost of these and other items was $2,000,000.

Turning to Europe, a new Austrian rifle is spoken of, of about 0·196, or far smaller than even our Lee navy rifle, but it is not yet adopted. In England enough magazine rifles have been completed to arm the entire regular forces and also the militia. Very full accounts are given of the comparative trials of the Martini-Henry and the Lee-Metford. Germany is said to be adding to her rifle a device to prevent the danger of double feed. Holland has armed her troops, as has been noted, with the 0·256 Mannlicher. Italy presents a rifle invented by Captain Cei for which great claims are made. Russia is content, like ourselves, with a 0·30 rifle, hers being known as the Mounzin. Of course, enormous sums will be required for her supply. Turkey has recently ordered 200,000 Spanish Mausers of caliber 0·301.

Specially interesting to us are Spain's experiments with small arms. She formerly had the 0·301 Mauser, but is credited now with adopting the 0·276. The larger caliber, however, has been sent in quantities to Cuba. A few months ago a proposal was made to transform the Remingtons now in use to the 0·276 caliber, but without magazine, thus giving uniform caliber throughout the service, but the objection was made that too many of them were service worn. In conclusion, it is said that "about forty battalions of Spanish infantry of the army of operation in Cuba are armed with the Mauser. Most of the cavalry in Cuba is armed with the Mauser carbine. The battalions which sailed for Cuba in November, 1895, were, however, armed with the Remington. The last battalions sent to Cuba in February, 1896, were also armed with the Remington."

A list of service revolvers and pistols shows a general clinging to calibers over 0·40 with a correspondingly heavy bullet weight. Our army Colt 0·38 is among the lightest, with the exception of the new Russian pistol and the revolvers of French officers and Swiss dismounted officers. One of the points insisted upon is that the bullet must be heavy enough to produce the proper shock effect in stopping a man or perhaps even a horse, and that fifty yards is ordinarily the limit of useful range.

The notes on equipment declare that in the matter of neat, attractive looking stables, the English, Germans, and Austrians can teach our stable sergeants valuable lessons. The stables are paved, the horses have more bedding than ours, and neatly plaited straw braid is put along the heelposts and elsewhere where a horse might be injured. Saddles and other articles of horse equipment and artillery harness are the natural buff of the leather in all European services. Halter shanks for garrison use are made not of leather, as with us, but of rope, which is stronger and cheaper.

The English and French carry the carbine in a boot on the off side, hanging vertically, but the Belgians and Austrians carry it slung over the back. The Germans carry it like the English, when mounted, but the carbine has a sling for carrying it on the back if dismounted. In foreign services privates do not usually carry revolvers. At Woolwich, cadets in practice at moving targets use the revolver with either hand. The Germans carry the saber attached to the saddle behind the left thigh, and some squadrons have scabbards of wood covered with black rubber instead of steel, as being less conspicuous and noiseless. The Belgians carry the saber with a V-shaped strap, with a frog on the rear side of the saddle. In foreign services both a curb bit and bridoon are used, and the horses appear better trained than ours. Their curbed bit is usually very heavy, notably the German, in the mouthpiece, but the Austrians have a light bit, much like ours, but with more curve in the branches. As to horseshoes, the English and Belgians, instead of throwing away the halfworn shoes, as we do, make them over, and consider them more durable than new ones. The saddle generally used is the English riding saddle or some modification of it, with often a sort of pad about the edges of the side flaps in front of the knee. A pair of pouches at the pommel seems to be preferred to saddlebags like ours. Our saddle blankets are softer and finer than the foreign, but the English, Belgian, and French have a cheap and durable linen nose bag much lighter than ours, and foreign halters are also lighter.

The Austrians have recently adopted a light, strong, waterproof linen shelter tent, rifles and fixed bayonets constituting the tent poles. The pieces can in an emergency be used as a storm coat. Samples of this coat tent are now under test at some of our forts. The so-called tortoise tents, made in London, accommodate many men for the weight of canvas, and the Kamtschatka tent is also worth noting. Inflated sacks or balloons are used for helping to cross streams in Hungary. Iron bedsteads without springs and bed sacks stuffed with straw seem to be the rule in Europe. In a Garde regiment in Berlin bread and coffee are served at each meal, with meat and peas for dinner and meat on Tuesdays and Thursdays at supper, and anything more the soldier bought out of his pay.

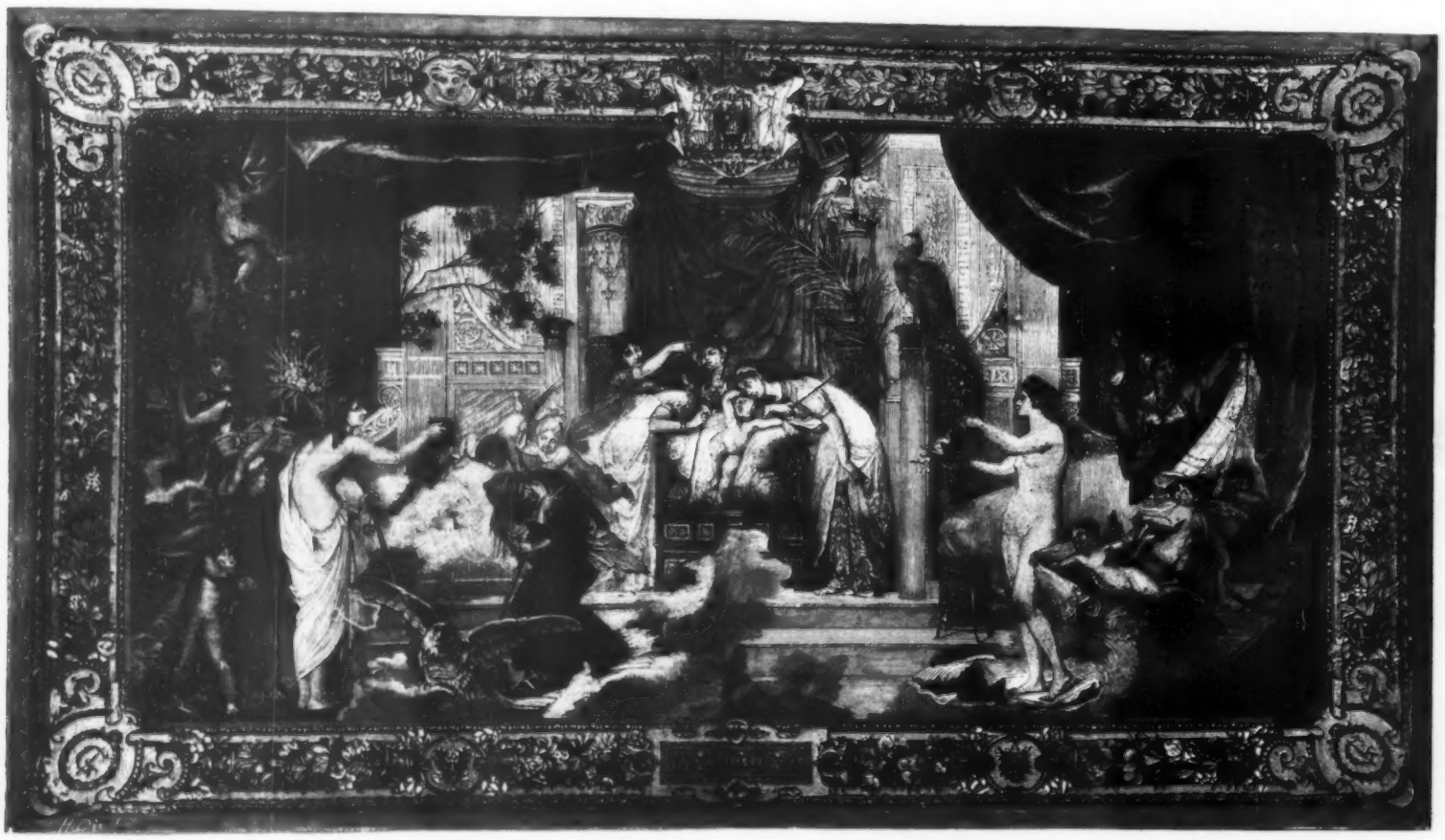
For infantry equipment the cowhide knapsack with hair on the outside seems universal in Europe, and there is constant drill with the full pack. Our Mills belt is, in convenience and comfort, far ahead of foreign cartridge boxes. The European soldiers generally carry a larger cooking utensil than our meat can, and in fact it is usually carried outside of the pack; but as our meat can, with the system of company messes, is rarely used except as a plate, it is better for our use.

Aluminum seems to be used very extensively for such articles as canteens and cups, and in our seventh infantry it is used for shelter tent pins. The most promising alloy in this country is nickel aluminum, which, like the Victoria alloy, is adapted for castings. A pound in weight can be saved for the soldier on the meat can, canteen, and cup alone by making them of aluminum. Steel-faced horseshoes, saddletrees, drum shells, spurs, and stirrups are among the other things experimented with in this metal.

THE "GODDAUGHTER OF THE FAIRIES."

THE "Goddaughter of the Fairies" is the most beautiful tapestry that has been produced by the Gobelins manufactory for a number of years. It was, as well known, presented to the Czar on the occasion of the fetes attending his coronation, and this little present, which was superfluous as a gage of friendship, was received by our imperial friend with as much pleasure as we experienced in offering it to him.

Through the reproduction that we give herewith, our readers will be able to judge of the interest of this important composition, which measures 14 by 24 feet, and was designed by Mazerolle, to whom we already owe the cartoons of the eight beautiful panels that decorate the buffet of the opera house. The border, which well befits the picture, is by Mr. P. V. Galland.



THE GODDAUGHTER OF THE FAIRIES—GOBELINS TAPESTRY PRESENTED BY THE FRENCH GOVERNMENT TO THE EMPEROR OF RUSSIA ON THE OCCASION OF HIS CORONATION.

Our engraving dispenses with the necessity of a lengthy description. In the center of the subject the fortunate child which has just been born opens its eyes amid the smiles that the good fairies that have been invited to the fete lavish upon it along with their presents, while the belated godmothers are coming to the front, one of them with a handful of flowers and the other presenting in a nacreous shell the pearls designed for decorating the young beauty in the cradle later on. To the left Carabosse, the wicked fairy, who has not been invited, but who always finds a way of following in the footsteps of her beneficent sisters in order to slip in a perfidious gift, is endeavoring to approach the group. She will not succeed in doing so. See with what zeal the chubby faced Cupids are castigating her in order to drive her away. All this is arranged in a harmonious equilibrium of gestures and forms, and, even without seeing the harmony of the colors, one may divine the perfect grace of the whole.

The tapestry is signed with the names of Edward Flamant and Francis Munier. In fact, it is to these two skillful workmen that is due the honor of having made a success of the technical execution of the work in which, under their orders, twenty experts of the manufactory assisted. The "Goddaughter of the Fairies," put on the loom in 1879, was not finished till 1888, with intermissions in the work, it is true. It was none the less a long winded work, and the beards of the artisans might have grown gray between the first and the last needleful.

After it was finished, the tapestry figured at the International Exposition of 1889, and later on was sent to the Chicago and Bordeaux expositions as the most perfect specimen of what the Gobelins establishment was capable of producing.

One of our contemporaries states that in the capital of the Gironde the "Goddaughter of the Fairies" made an unfortunate conquest. An aged American lady became smitten with it to such a point as to multiply offers for the acquisition of it, and, from bid to bid, finally proposed to cover it with gold coins as the purchase price.

The story is amusing, but it was not necessary to shove aside the heap of dollars of this Carabosse of petroleum wells. At the very first offer she was informed that the Gobelins did not sell its products, but executed them only upon orders given in advance and authorized by ministerial decision—generally in favor of cities and museums. Moreover, the private individuals capable of presenting themselves in the way of customers would not be numerous. The manual labor in Gobelins tapestry amounts to 4,000 francs per square meter.

After the Minister of Fine Arts had decided to send the "Goddaughter of the Fairies" to Emperor Nicholas II, the arms of the Czar were woven at the upper part of the border. This work was very delicate, because it was a question, in the first place, of matching the shade of the escutcheon with the sober colors of the tapestry; and, in the second place, because it was necessary to proceed quickly. This double difficulty was conquered by workman Hurity, who inserted the coat of arms in a portion of the border previously freed from wool, and who finished his task in two months.

The presentation of Gobelins tapestries to sovereigns friendly to France was quite customary under the different monarchies, but, since 1870, the practice has been abandoned. Under the present republic only two gifts of this kind have been made—one to the King of Denmark, on the occasion of his silver wedding, and the other to the Czar, under the present circumstances.

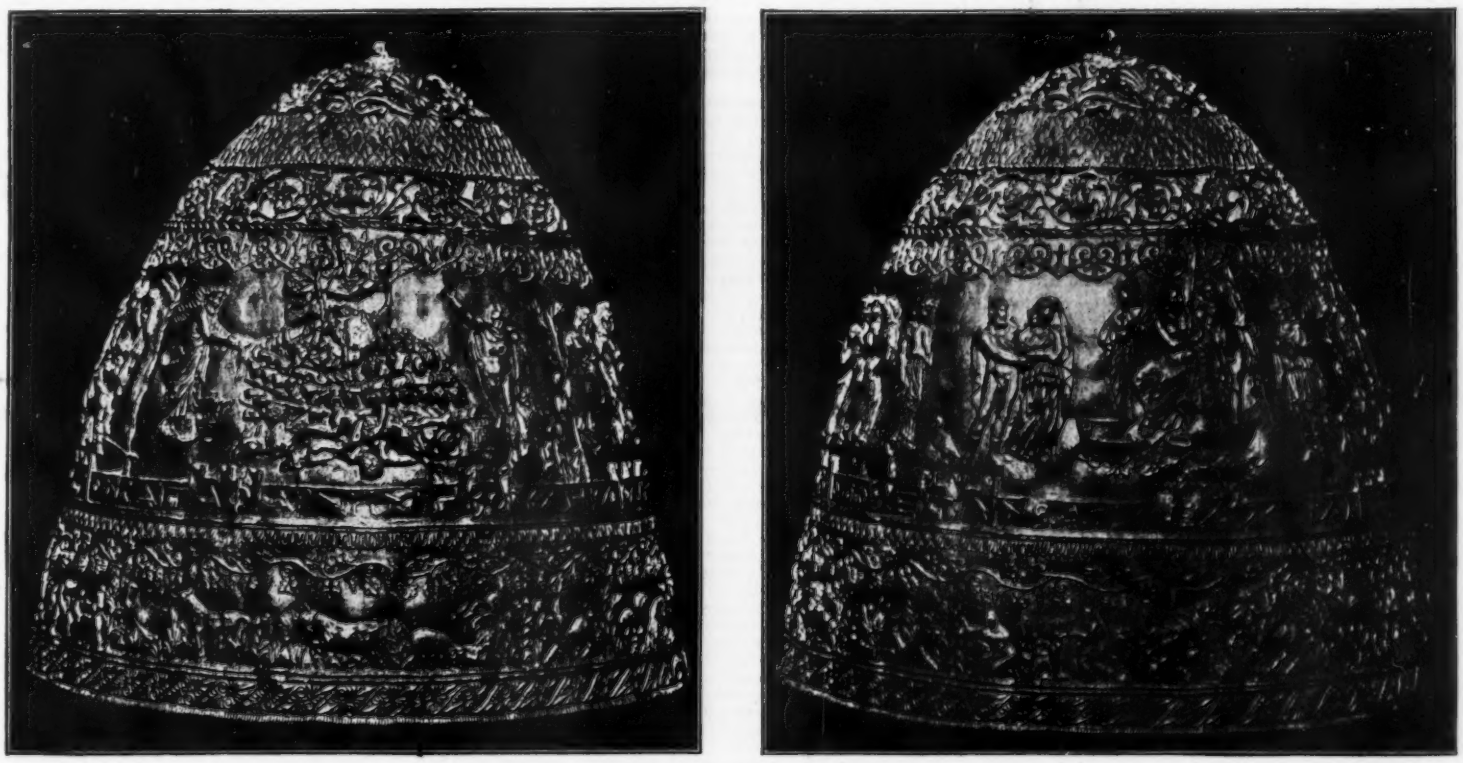
Let us hope that the good fairies, who have just started for Moscow, will not forget that they are French.—Le Monde Illustré.

THE GOLD TIARA OF THE SCYTHIAN KING SAITAPHARNES, NOW IN THE LOUVRE.

THE museum in the Louvre, Paris, has recently been enriched by a rare specimen of the ancient goldsmith's art. We refer to a gold crown which is most interesting, both on account of its beautiful and artistic workmanship and of the inscription which it bears, and which greatly enhances its value from a historical point of view. Some call it a helmet and others a tiara (triple crown), but as the latter term is so seldom applied to ornaments for the head used by the ancients, the word crown would seem more applicable. It is made in the shape of a sugar loaf, like the headgear often seen in antique decorations. Head coverings of this shape were used particularly by the Orientals, and were generally made of cloth or felt, but the same form was given to helmets of iron and bronze. Herodotus called such ornaments for the head, especially those worn by the Persians, tiaras. The tiara above referred to, together with some other articles (necklaces and pendants ornamented with filigree work and precious stones), also of fine workmanship, were found within the last year in a sepulchral mound in the Crimea—so rich in antiquities—and was sold for about $38,600 to the Louvre, where it is on exhibition and attracts crowds of curious people, many of whom do not appreciate the artistic work, but all wonder that it should have been so well preserved. The tiara is as brilliant as if it had just come from the workshop, but its genuineness has been established beyond a doubt, and it is justly considered one of the most wonderful pieces of antique work ever found. When discovered, it was protected by a stone arch.

The tiara is 8¼ in. high and the diameter of its base is 7 in. It is made of gold and is divided into seven parallel zones. Above the purled edge there is a decoration of conventionalized palm leaves which serves as a ground for a frieze of lifelike figures of human beings and animals; one of the latter is being killed by a Scythian archer; a knight is represented as fighting a winged lion, and the figure of Victory behind him indicates that he will be victorious. The costumes of all the figures in this frieze are those worn by the ancient Orientals, while those of the figures on the main field are all classical in conception. This field represents two scenes from the Iliad, separated by foliage, in the former of which Achilles is seated and Ulysses is leading toward him Briseis (Hippodamia), the daughter of Brisens. Before him are numerous gifts, including richly decorated basins, vases, drinking vessels, etc. The other scene represents the funeral pile of Patroclus built on the bodies of victims sacrificed in his honor; above the body of Patroclus are two genii. At the right of the observer Achilles weeps for his friend, and at the left we see Calchas bringing an offering. Above these scenes are zones of classical decoration, and the tiara is completed by a coiled snake whose raised head forms the summit.

What lends especial historical value to the tiara is the Greek inscription done in relief directly above the main zone. It is written on a kind of mural crown which seems to represent the wall of the city where it was made, and when translated reads: "The Senate and People of Olbiopolis to the Great Invincible King Saitapharnes." Olbiopolis is the city of Olbia, in Dacia, a Greek settlement on the Black Sea. This present to the Scythian king was doubtless a kind of tribute paid by the citizens of Olbia to secure themselves from invasion by their restless neighbors. From an inscription found elsewhere it is evident that Protogenios, a citizen of Olbia, paid a tribute of seven talents to King Saitapharnes, and it is probable that the tiara was sent for a similar purpose. Everything, especially the costumes of the figures, indicates that the tiara of Olbiopolis was made in that city three centuries B. C., and apparently the knight dressed in Scythian costume and fighting the winged lion represents the king himself, the "great invincible Saitapharnes."—Illustrirte Zeitung.



THE GOLD TIARA OF THE SCYTHIAN KING SAITAPHARNES, IN THE LOUVRE, PARIS.

DEAD CITIES OF THE FAYUM.

THEY are dead absolutely, not shrunk to villages like Memphis and Thebes, but as utterly lifeless as the desert which embraces them now. The sown land on whose outermost fringe they lie has shrunk within its ancient limits and left their streets and squares and roofless houses to be lost under drifts of sand.

The fact of their entire isolation and one further fact make the mounds round the edges of the Fayum singularly worth exploring, even as sites go in the basin of the Nile. They have not, indeed, to show the remains of great cities which had a more than local fame, but of little centers of life in the richest province of Greek and Roman Egypt—small brick towns perched on slight eminences above those broad arable fields and marshes, stocked with cattle, which the papyrus tax receipts show to have yielded so much to the imperial revenue.

Trade of a sort passed through them, when the merchants were traveling between the home capital, Arsinoe-Crocodilopolis, and the Oases, and also they came in time to be something of health resorts; for when it was June in the Nile valley, and the river had become low and foul, the great sheet of Lake Moeris lay broad as ever in the view of these towns, and the winds of the Libyan Desert came across its cool waters. Therefore, although their walls are but of mud brick, and they have at best a small temple apiece built of any material more sumptuous, they stood far above the rank of mere villages, and would be worth exploring even were not each so perfectly preserved under the sand as to be a small Pompeii.

But, as has been said above, there is a further count in their favor—briefly, that more than all other sites of Egypt these yield papyrus. The famous water plant was, it seems, dirt cheap in the Fayum, as in the Delta; but, whereas in the climate of the latter and under its salt soils the papyrus product quickly decays, the Fayum desert lies almost within the rainless area. In the streets and houses on its mounds every rubbish heap, every lumber room, has conserved its scraps of waste paper intact, and there is hope of lighting now and again on a little library or record office, or at least on the torn remains of some of the rolls they contained once, not thought worthy to be taken when the town was abandoned. There remains also to be added the chance of finding in the tombs a papyrus intact between the knees of the dead or serving for his pillow, or even broken up and gummed to form a papier mache coffin. But so thoroughly have the cemeteries been plundered in antiquity, and so often do the graves lie in damp salt strata, that experience has shown the towns themselves to be the happier hunting grounds.

The native dealers of Cairo and Medinet el Fayum have long known the safe and easy sources of spoil, and have worked for the benefit of European museums unregarded and with no obligation to keep or publish records. Mr. Petrie alone has exploited any part of the Fayum desert with a scientific object, but his efforts were confined to that corner where the Bahr Yusuf breaks through from the Nile valley. The topography of all the rest of the circle remained unknown, and the miscellaneous collections of Fayum papyri in Cairo, Vienna, Berlin, Paris, and London have lost half their interest and value from the uncertainty as to exactly where or how they had been found. It has been reserved to the English society, the Egypt Exploration Fund, to obtain the first precise scientific facts about these papyrus hoards and the first additions to our scanty knowledge of the map of the ancient Fayum.

In December last the representatives of the society, Mr. D. G. Hogarth and Mr. B. P. Grenfell, having obtained the concession of a long strip of the northern desert fringe, went down into the Fayum and settled on the two largest mounds east of the lake, called by the natives Kum Ushim and Kum el Qatl (i. e., "Mound of Murder.") To this region the desert routes from the north, whether from Nitria or Alexandria or Memphis, must have converged on their way to Arsinoe or the Lesser Oasis; and it was not long before the excavators discovered from the papyrus documents which were unearthed in the second mound that they were, in fact, on the site of Bacchias, a town set by Ptolemy (as Bacchis) on the desert road from Alexandria, and conjecturally placed hitherto by topographers in all localities but this.

In like manner the first named mound was determined to be Karanis, a name read more often on Fayum papyri than any other, except Arsinoe, and that of the city which lies at Dimeh, but owing to the absence of any record of the provenance of these papyri, never until now identified with any particular site. Karanis showed abundant evidence of the plundering which had produced these papyri, and it yielded far less to the explorers last winter than Bacchis; but from its tombs came rather unexpectedly certain large fragments found lying loose in the sand, of which one is in Latin, the rarest of all scripts on papyrus, and three contain portions of Greek literary prose texts, not yet identified with any known author. Furthermore, there were many scraps of Homer, and such were found also at Bacchis, but these last were exceptions to the rule of non-literary documents prevailing on that site. By way of compensation, however, the diggers of Kum el Qatl were rewarded with two fragments of peculiar importance. The first contains a large part of a rescript of an emperor, probably Commodus, addressed apparently to all provinces and cities of his empire. This text is beautifully penned by a local scribe with very deficient knowledge of Greek orthography. The second (also second century) purports to be a letter written by the Emperor Hadrian to a friend on the subject of his own approaching death.

The fragment seems to be a schoolboy's copy of some once well known text. Paleographers, rather than the general public, will welcome the intelligence that a great many documents and fragments of documents

have been found, dated to the first century B. C., a period of which hardly any papyri exist. The most part were found in a chamber of the temple of the local god of Bacchis, discovered and dug out this year, and among them are two little complete petitions addressed to the god, whereof one seems to contain the prayer of some lovelorn maiden fearful that her beloved one may slip through her hands and depart from the city. Less pleasing, but always of great interest to the student of ancient life, are the mass of legal documents, memoranda, letters, and the like which these two towns have yielded. So many were found in one spot at Kum el Qatl that it appears probable that the situation of the local record office, or at least of the outpourings of its official waste paper baskets, was chanced upon.—London Times.

RUINS OF PREHISTORIC KOPTOS.

THERE is now on exhibition in London an interesting collection of antiquities found in recent excavations made on the site of Koptos in Egypt. The ancient site of Koptos, says the New York Sun, formed the Nile termination of the oldest trading route of the world, the roadway passing through the valley of Hammamat to the shores of the Red Sea. According to tradition, Koptos was one of the first settlements founded by the dynastic Egyptian immigrants when they arrived from their home in the sacred land of Punt in southwestern Arabia. Archæologists have looked with hopes of obtaining valuable material, toward the site of Koptos. Prof. Petrie returned not long ago after spending eleven weeks in excavations there, and the collection now on exhibition is a part of the result of his labors.

The site of the temple of Koptos was thoroughly cleared, and the result was the discovery of no less than six successive temples, ranging from the most remote prehistoric time to the age of the Ptolemys. Hundreds of objects of great interest were discovered. Hitherto Egyptian art and civilization have presented a striking paradox. The further back one goes the better the art. In the lowest strata of the temple of Koptos Prof. Petrie discovered the remains of an ancient settlement, which for the first time reveals prehistoric Egypt.

There is on exhibition in his collection a massive head of a statue, which is one of three figures found at a great depth beneath the Ptolemaic temple. The statues themselves were thirteen feet high, and were little more than truncated cones, the arms and legs being indicated by hammered outlines, and the ears and whiskers were indicated in the same way. No trace of chisel work, however, can be found on any of them. Girdles are around the waist of each, and upon them are a series of curious drawings, supposed to be the totem figures of the god of the primitive people. A writer in an English paper says that these are probably the first statues of Min, the god of Koptos. The face is in no way indicated, and it is believed that it was represented by a wooden mask.

In the rough sculptures on the bands and girdles around these figures is represented, among other things, the fetich pole of Min. It is an upright staff, with a bouquet of flowers at the top, and surmounted by an ostrich feather. Around this pole are hung offerings, consisting of shells and swordfish. On another girdle there is a representation of an elephant and a remarkable drawing of the head of a gazelle. These drawings serve to connect the early settlers with the shores of the Red Sea and the district of Somaliland, where the elephant and gazelle would be known to them.

Probably of equal interest is a collection of rude pottery made of coarse Nile mud, carefully polished with red hematite. This work is supposed to belong to the period of the first or second dynasty, as the representation of a dog with a peculiar rope collar, which is modeled on a large oval stand, is never found after the time of the third dynasty.

These pieces of pottery show the work of a skillful school of artists who had learned to model in clay. These artisans used in working soft stone and wood the same finish that they imparted to the plastic class.

Some of the objects representing the prehistoric period are noticeable. One of them is an alabaster vase inscribed with the cartouche of Kerfu, the builder of the first pyramid. Two of the finest pieces of work in the collection represent the period of the twelfth dynasty. One of them is a figure of Usertesen I dancing before Min and the other is a representation of Aminemhat standing before Min. The former of these is in intaglio, and in the latter the hieroglyphics are raised. They are the gem of the collection by reason of their delicate finish and minute attention to detail. Some of the foundation deposits of the temple of Koptos, built by Thothmes III, were found in pits under the centers of the wall placed at the bottom of the pit, the upper part being filled in with hundreds of vases. These deposits consist of bronze models of tools, knives of various sizes, narrow chisels and axes, and all of them inscribed with the words "Thothmes, beloved of Min of Koptos." A number of model corn rubbers, made of sandstone and inscribed with blue paint, were also found. Several objects hitherto unknown were found in the Ptolemaic temple.

Three tanks, having fourteen steps on each side, are among them. They are evidently models of the sacred tank of Min, and one of them bears an inscription of Aristius Saturnius. It is supposed that these tanks were used by the wealthier persons to perform ablutions of their hands and feet before entering the temple and thus to avoid using the great tank of the common herd. There is a model of a foot at the bottom of one tank. This collection has demonstrated the richness of the field of Koptos, and further interesting discoveries are expected.

THE ANKLE JOINT IN MAN, AND THE INHERITANCE OF ACQUIRED CHARACTERS.

PROF. RETZIUS has lately published an account of certain observations on the fœtus of Swedes, which, in connection with similar observations recorded by Surgeon Havelock Charles on the Punjabite, he believes to support the Lamarckian view that acquired characters are inherited. He endeavors to show that the evidence in support of the theory is to be found in our own skeletons.

Some years ago, Prof. Arthur Thomson pointed out that in certain races of men who habitually adopt a "squatting position," the tibia and astragalus present additional articular facets, allowing greater flexure of these bones upon one another than is possible (or at any rate normal) in Europeans and other civilized races who have given up squatting, and in which these facets are absent. Accompanying these facets there is a retroversion of the head of the tibia. Both these characters are present in apes and in certain prehistoric races, and Surgeon Havelock Charles described, a year or two back, a series of instances of their presence not only in the adult Punjabite, but in the fœtus. At the meeting of the British Association at Oxford, Prof. A. Macalister exhibited these specimens, as well as similar specimens taken from British infants, and a discussion followed on the meaning of these peculiarities. Now Retzius ("Ueber die Vererbung erworbener Eigenschaften," Biol. Untersuch, n. f. vii) records these same characters in fœtal Swedes, from an early age, even up to eight months; and reviewing the facts, he comes to the conclusion—in which I think most of us would agree—that the presence of these characters, viz., the retroversion of the head of the tibia and "Thomson's facets," is a more primitive condition than their absence in normal Europeans of the present day; that they have been inherited from early times; and in those peoples which habitually adopt the "squatting" position they have become gradually further developed. This last conclusion is perhaps open to question; it is quite possible that even in these races they are less developed than in ancestral forms. But Retzius proceeds to contend that Europeans have undergone gradual change in their skeletons from generation to generation; they no longer sit on their haunches, and have gradually lost the power to do so, and as a consequence "Thomson's facets" have disappeared; and he concludes that "it is, therefore, we Europeans who, on account of changed habits, have undergone changes, and it is in us that these changes have gradually been inherited."

But here, it seems to me, that Darwinians would join issue with Retzius. His own and other observations show that the changes are not inherited; for the characters of the bones are inherited from the ancestral ape-like forms, and it is, surely, only on account of individual habit that the peculiarities are not present in the adult.

It is by no means clear what is the "acquired" character on which Retzius hangs his views. Is it the osteological peculiarity, or the habit of using chairs to sit upon, instead of employing the squatting posture? His own researches show that the osteological characters are not acquired, while the habit of walking upright and sitting on chairs is distinctly acquired, and it is in relation to this acquirement that the osteological peculiarities cease to be evident. Young children, as we know, can and do sit upon their haunches, and can move their legs and ankles in a way that an adult, unless he is fairly athletic, finds it impossible to do; and it appears probable that the disappearance of the facets in the adult is closely connected with the ossification of the bone, which will obliterate the facets now no longer brought into use. It would be interesting to examine in this connection the leg bones of "contortionists" and others who make a free use of their legs and ankles, for a very little practice enables even civilized men to employ exaggerated movements of their limbs.

Another point to which attention might be directed (which indeed may have been looked into) is the character of the articulation of the bones of the great toe in those races which make use of this digit. A casual observation on the skeleton of an Andaman shows that the articular surface of the first metatarsal with the entocuneiform is distinctly more rounded than in a European; a feature in which there is an approach to the condition in the apes. It might have been presumed that some difference, similar to that in Europeans and Punjabites, would be found in digitigrade and plantigrade mammals; but the result of a brief examination of skeletons of such forms is sufficiently surprising to be referred to; for instance, in the lion there is a facet of the same kind as, but not really homologous with Thomson's facet, at the lower end of the tibia. This is absent in the bear and the dog; it is also absent in the sea otter. It is present, however, in the beaver and other rodents; it exists in some ruminants, as well as in the horse, but is only slightly developed in the tapir, and is absent in the Suidæ.

CHEWING GUM.

No doubt the use of gums has done much to check tobacco chewing. Besides, many physicians prescribe them as tending to promote the appetite and to facilitate digestion—properties ascribed to the juices of the tree by the Mexicans—and also as a substitute for smoking, in the belief that the nicotine habit in many persons is a result less of craving for tobacco than of a certain nervous derangement which will be corrected by holding something in the mouth, or chewing it.

CHICLE.

Chicle is yielded by a kind of wild pear tree of the genus Achras, of the natural order Sapotaceæ. There is but a single species, the Achras sapota. The same natural order, by the way, embraces the genus Isonandra, which yields gutta percha, and the genus Mimusops, which includes the bully tree, or balata. Indeed, the chicle and balata trees are confounded to this day by such accepted authorities in medicine as the National Dispensatory and Foster's Medical Dictionary. It is an evergreen tree, with thick shining leaves and milky sap, and has been cultivated in places for its edible fruit—the "sapodilla plum," which is about as large as a quince and as yellow inside as a carrot, having two seeds. It flourishes in rich, loamy soil, and can be propagated from cuttings. The bark (sometimes described as "Jamaica bark") is astringent and has been used as a febrifuge, instead of the cinchona bark. The seeds, also used medicinally, are aperient and diuretic. The Aztec name for the tree was cochitzapotl; the origin of the name "chicle" has not been traced by the writer of this article.

The gum is more plastic and more easily kneaded than caoutchouc and is more elastic than gutta percha. At ordinary temperature it is solid and horny, but it softens at 49° C. and can then be moulded. Toward solvents it behaves like gutta percha, and when bleached it is very white.

The above is from the India Rubber World. The following is a formula for gum chicle chewing gum: Dissolve 7 pounds of gum chicle in water, melt 2 pounds of paraffine; then put 20 pounds of a good quality of sugar and 8 pounds of glucose into water and boil to crack. Pour the sirup on an oiled slab and put in sufficient of the gum mixture to make a tough mass. The flavorings should be added at this period. Balsam of Peru, 2 ounces, is sometimes added as well as an equal amount of balsam of tolu.

Some interesting information concerning the spruce gum industry is contained in an interview with the head of the firm of Curtis & Son, Portland, Me., which appeared in a recent issue of the New York Sun:

"I prepared and sold the first bit of spruce gum ever put upon the market in this country," he said. "That was in 1850. I am no longer a young man, you see, for I am now sixty-six years old. Yet," he added, laughing, "I take a still youthful interest in spruce gum. I began first away back in 1850 by going about the country with a cart and peddling the gum from house to house. In this way I went all through New England, and the first year I collected $6,000 in money. Then I grew ambitious and wanted to make the whole United States my field. It's just as good an ambition, that of subduing a nation to good healthy spruce gum chewing as subduing it to tobacco smoking. Well, I have personally visited almost every city in the United States and Mexico in the interests of this business. My first large order, I remember, came from a St. Louis firm. I sold them 36,000 boxes, varying from one to two pounds in each box, and delivered them all during the year. Now we have agents out all over the country. One of our men is to-day in Butte, Mon., another out on the Pacific coast. Of course, we have scores of competitors, but there is business enough to warrant many more."

When asked where the market for this gum was found, Mr. Curtis went to a large map of the United States, which hung on the wall of his private office, and drew his finger across it from east to west, starting with New York City as the southern point. "We sell almost entirely above this line—through the Northern States and up and down the Pacific slope," he said. "Probably Michigan, according to its population, uses more of the gum than any other State in the Union. Chicago and St. Louis are great spruce gum cities. New York City? No; New Yorkers chew pepsin. Do you know," he added, "this taste for spruce gum seems to be almost a hereditary one? The people living among the spruce forests, as in Maine, New Hampshire, northern New York, and Michigan, love the Spruce gum; so also do their descendants. The Southern market is small, and there the taste is an acquired one, like that for olives and celery."

Another firm in Portland has on hand at the present time about 200,000 pounds of spruce gum, which is being made ready for the market. The large wholesale houses buy a certain part of their gum prepared, ready for sending out again, but most of it they get in the rough state, and then put it through a steaming or "manufacturing" process in their own establishments. This so-called "manufactured" is pure spruce, but gets its name from the fact that it has been reduced from its original state.

At this time of the year, and all through the winter months, the spruce gum industry gives employment to hundreds of men in the forests of Maine, New Hampshire, northern New York, and Canada. For many of the farmers it forms an only source of income during the late fall and winter season. An experienced "gummer" makes on the average $2.50 a day. His outlay is small, and the work is considered particularly healthy. He first equips himself with a coarse meal bag, sewed up at the open end, and with a hole cut out of the center large enough to permit of its being drawn over his head. This large opening is usually bound around and stayed with leather. The bag in this way forms two pouches, one of them falling down in front and the other over the back of the gummer. In one of the pouches he stores away certain needed tools, as hammer, hatchet, large knife, etc.; in the other, such a supply of food as he thinks will be needed. The food consists mostly of canned meats, a box of baked beans, tea, and bread. These he warms and prepares over a fire.

The gummer's stay in the forest depends, of course, on his success in finding a ready supply of gum—sometimes it is only one or two days, sometimes two or three weeks. During recent years so many men have gummed over these forests that there are now certain well-known spruce camps, made of boughs and extremely rough and primitive, yet they furnish very comfortable quarters for the men at night. It is a tradition among the gummers that no one has ever yet taken cold from lying out in the spruce forests, however exposed his condition or intense the cold. Certain it is that they endure rain, snow, and cold with a glowing health that would put the trained athlete to the blush. The old expert gummer loves his work, and it is a local saying that the men "live eight months in the year in order to gum the other four."

The greatest quantity of gum lies in rifts which run up and down the trunk of the spruce tree. An expert gummer will sight a rifted tree by the slightly oval round of its trunk, even before he is near enough to see the rift. Often a tree has to be felled to get at the gum lying in the rift, but, if possible, the trees are climbed. This rifted gum is usually a little hard and dark, but it is perfectly marketable. The best quality is found near the top, and exudes in small bubble-like blisters. This is quite plastic and light colored. A tree must be three or four years old before the gum is hard enough for use, and a single tree may yield as much as five dollars' worth at one time. The gum is carried out of the forest in the meal bag pouches, which hold from one hundred to one hundred and fifty pounds each.

In most regions the gum is sorted into "first-class" and "second-class," either in the forests or near them. The first quality brings from seventy-five cents to one dollar a pound, and the second—the hard, dark gum—from twelve cents to fifty cents. This second-class goes through the steaming process.

The backwoods manufacturing process is a separate industry. Hot steam is led from a small boiler over an immense tin pan. A layer of spruce boughs is put above the pan, then a layer of second-class gum; then again alternating layers of spruce boughs and gum. The steam melts the hard gum, which filters down through the boughs into the pan. This melted product runs from the pan through an inclined trough into a

large receptacle, where it cools to about the consistency of sorghum, when it is taken out, pulled, and stretched in the same way as old-fashioned molasses candy. After the stretching it is rolled on a board or table, and little pieces are snipped off with sharp shears and wrapped in bits of colored paper for the chewing public. The farmers' daughters get fifty cents a day for pulling gum.

MANUFACTURE OF GLASS TUBES.

MANOMETER tubes for boilers and similar apparatuses are annealed very carefully and finished in the glass houses ready for the market. Their composition makes these tubes unsuited for glass artists' material.

Solid glass rods or bars are from 2·20 millimeters thick and over. The thicker ones contain usually blisters and can hardly be used by glass artists. The exterior of the tubes or rods suitable for this purpose must answer the following requirements:

1. The glass must be pure, transparent and free from blisters and air channels.
2. The tubes must be cylindrical to their whole extent or at least as much as possible.
3. The cross section must be circular, not elliptical.
4. The walls must be of uniform thickness throughout.

The glass used is divided into three principal kinds according to its composition:

1. Easily fusible soda glass. This glass can be worked better than any other. It is mainly produced in Thuringia, but Russian factories, too, produce a very creditable article. The surface of this glass decomposes easily, however, especially under the influence of water or acidified vapors.

2. Easily fusible lead glass (flint glass). Of this kind of glass the French product predominates. It melts still more easily than soda glass, and is distinguished by its great purity; it possesses fine luster and excellent whiteness. It does not crack easily, when suddenly cooled or heated, but becomes soon black in the flame of reduction and has to be treated carefully while being worked.

3. Potash glass, difficult to melt, so-called Bohemian glass. It can be softened with difficulty only, but is practically indispensable for apparatus which is to be exposed to great heat. This glass is used especially for tubes intended for analysis of organic combustion. The tubes made of this glass are seldom so pure and uniform as good tubes made of the first two kinds. The Bohemian glass is usually of a greenish shade.

Not belonging to the three kinds of glass mentioned are the colored and figured tubes (filigree tubes). These must be heated very carefully, as some colors change in the oxidizing flame, others in the reducing flame.

If soft glass is heated slowly to red heat, it becomes dull, opaque and like porcelain, and cannot be made soft under preservation of its luster. This process is designated by the technological expression, "deglassification;" glass, thus deprived of its principal characteristics, is called "Reaumur porcelaine." A microscopical examination of this glass reveals numerous crystals in the substance of it, such glass representing in a certain sense the transition of glass from the amorphous state to the crystalline. This "deglassification" occurs more or less quickly, and depends upon the more or less complicated composition of the glass. The more silica the glass contains, the quicker it will become deglassified; certain physical characteristics are changed thereby, the specific gravity, for instance, is increased by deglassification.

But a few kinds of good glass do not become deglassified during extended working under the blowing flame. We shall see further on that sometimes glass has to be heated a long time, so that more substance can be collected; often a defective ball is allowed to contract and afterward blown up again. This, however, succeeds only with the best kinds of glass. Bohemian glass, which is hard to melt, becomes deglassified so quickly that work on it has to be stopped after it has been once weakly heated. Very good glass even shows a sort of deglassification which is caused by decomposition. This occurrence is observed on old tubes, which have been stored away for a long time: the decomposition, however, occurs the quickest when the tubes are exposed to the continued action of water or acids and lyes. The surface of the glass loses in this case a part of its alkali contents and becomes more difficult to melt. It is then in a general way no longer identical with the inner glass substance and combines with the latter only at high temperatures, which cause the entire glass substance to become liquid. This explains why by slight heating over a small or sooting flame, which just suffices for bending or stretching the tubes, the latter become dull, that is, lose their luster. This is especially noticeable at the inner side of the curve, where the glass has been compressed. Seen under a microscope, this dull tone represents a number of wrinkles which run in various directions, like in a piece of crumpled cloth. If the tube after being heated and having become dull at one place is stretched, transparent stripes running lengthwise are noticed in the dull part. By heating such a tube slowly to the melting point, it becomes transparent again and can be worked easily. It will stand repeated heating without deglassifying. A slightly dull tone remains only at the junction of the heated and not heated parts. Tubes made of glass which contains much soda are especially subject to deglassification.

Many kinds of glass become brittle when heated to high temperatures, which, however, are not sufficient to make it soft. This brittleness is principally noticed while the glass cools off; then a slight shock or bending is sufficient to produce a crack in the ready article. This characteristic ought never to be overlooked in the manufacture of complicated chemical apparatuses.

The elastic reaction of glass is observed sometimes at ordinary temperature. A glass tube bends easily by the influence of gravity when laid with the ends horizontally upon two supports. If it remains in this position for a great length of time, the curve will remain, even if the tube is given an upright position. This is noticed in the case of high-priced thermometers. The curve, however, can be removed by turning the tube over, and for hurrying the straightening process small weights can be attached to it. The elastic reaction of the glass tube produces in the thermometers the well known change of the zero point. In the last few years, however, glass has been invented showing this feature to but very small degree. Such glass is produced in Schott's laboratory at Jena, being known by the name of "normal (standard) glass." For the sake of distinction each tube is provided with a red stripe, running lengthwise. Green glass tubes marked similarly are being produced by Tonelot, of Paris. Schott's tests showed that thermometer glass ought to contain but one of two alkalies, potash or soda. The addition of a second alkali, even in very small quantity, increases the elastic reaction of glass considerably. But as glass containing only one alkali is very hard to melt and deglassifies easily, it was necessary to add other substances to make the glass fit to be worked. The batch of the Jena normal glass is, therefore, composed as follows:

	Per cent.
Soda	14·5
Lime	7·0
Clay	2·5
Oxide of zinc	7·0
Silicic acid	67·0
Boracic acid	2·0

The changes to which the zero point is subject are six times smaller with this glass than with the common Thuringian glass, and three times smaller than with the English lead glass. Its resistance against the attack of water is far greater than that of any other kind of glass known.—Diamant.

THE PREPARATION OF TEXTILE FABRICS FOR PHOTOGRAPHIC PRINTING.

By W. ETHELBERT HENRY, C.E.

PHOTOGRAPHIC vignettes upon bands of silken ribbon make handy bookmarkers which cause pleasant reminiscences of one's holiday. Souvenirs of this class are very inexpensive, yet they often form more acceptable presents than paper prints.

The best ribbon for the purpose is a pure China silk (without rib markings) or a really good satin; the color is, of course, a matter of individual taste, but personally I prefer a pure white or pale cream.

To prepare the silk for printing, it must be first immersed in a salting composition, and then, after drying, in a solution of silver nitrate to render it sensitive to light.

A salting solution that appears to be a favorite is made as follows:

Alcohol	1,000 parts.
Benzoin	8 "
Mastic	5 "
Cadmium chloride	30 "

The silk must be immersed in this solution for about 20 or 30 seconds, and then placed for a moment between sheets of clean white blotting paper to remove the surplus solution; it may then be placed to dry in a current of air. A stock of material can be thus salted, as it will not deteriorate by keeping, and is ready for sensitizing at a moment's notice. When quite dry it should, of course, be packed away in a place free from dust.

The sensitizing bath is as follows:

Silver nitrate	12 parts.
Water	100 "

or roughly speaking, 60 grains of silver nitrate to an ounce of water.

The salted fabric should be immersed in the silver solution for about one minute, blotted between clean white paper, and then put away to dry in a dark place. Drying may be accelerated by heat; for instance, the ribbon may be placed between several folds of blotting paper, and a hot iron passed over it—this will not only dry the material, but will also render it perfectly flat. In any case (whether dried spontaneously or not) it should be ironed before printing, as this treatment, by flattening the fabric, prevents failure that might otherwise occur owing to uneven contact between material and negative.

Printing should be carried considerably deeper than would be the case with P.O.P.; and care must be observed when examining the impression, otherwise blurred lines may occur. A good plan for obviating this trouble is to attach the silk to a slip of thin card by gumming the ends to its back. The thin card thus affords a foundation that will prove a decided help while printing; of course, the gum will dissolve in the washing waters, and the silk will be none the worse.

When the prints are sufficiently deep, they must be thoroughly washed in five or six changes of water (about five minutes in each) and then toned in any good toning bath suitable for P.O.P., the only precaution necessary being to dilute it with an equal bulk of water, if it tones too rapidly. The following bath is a good one for the purpose:

Soda bicarbonate	10 grains.
Water	10 ounces.

When dissolved, add—

Gold chloride	1 grain.

The prints must be kept moving all the time they remain in the toning bath, and when sufficiently toned they must be rinsed in clean water and then fixed in—

Hypo	1 part.
Water	10 parts.

for about ten or fifteen minutes.

After fixation, a good washing for a couple of hours in several changes of water will complete the prints, which may then be hung up in the open air until almost dry; a final ironing between pads of clean blotting paper will give them a nice finish.

These prints may be finished in monochrome or water colors with good effect. The colors used should be diluted with alum water, about a 10 per cent. solution being suitable.

No matter how much care one takes during printing, light will sometimes get in around the margins and cause an impression beyond the actual confines of the vignette; sometimes the vignette itself is not altogether satisfactory. It is as well to know that the marks can be entirely removed by treatment with solutions of potassium cyanide and iodine, but we must also bear in mind that the solutions are most active poisons, and should be kept closely locked up.

Two separate solutions should be made:

(A) A saturated solution of potassium cyanide in water, and

(B) A saturated solution of iodine in alcohol. A "saturated solution" being as strong a solution as can be made (by shaking) at the ordinary temperature.

For use we must mix four drops of A with two drops of B, and apply to the silver stain with a tuft of cotton wool. In their concentrated condition, the solutions work with extreme rapidity, so they may be diluted for use as required; the addition of water simply slows the action and brings it under control.

Another favorite method of sensitizing fabrics is to first immerse them in a salting bath made by pouring twenty ounces of boiling water on a hundred grains of ammonium chloride and sixty grains of Iceland moss, which can be bought of chemists at a shilling a pound. Stir the mixture until nearly cold, and then filter and immerse the fabric for fifteen minutes. After drying the material, it may be sensitized by a few minutes' immersion in a thirty or forty grain bath of silver nitrate (i. e., thirty or forty grains to each ounce of water), and then dried and ironed flat before exposure.

In addition to making useful bookmarkers, these vignettes on silk or satin form very neat covers for scent sachets, pincushions, etc. But at this stage I had better leave the matter, simply expressing a hope that some of the lady readers of this article will give the process a practical trial; they will, I know, be able to turn it to account in far more ways than I dare mention, perhaps even going so far as to use vignetted views as part of their personal adornment.—The Amateur Photographer.

ON THE RATIONAL MANUFACTURE OF INK.

THE manufacture of writing ink is still carried out in an exceedingly empirical fashion, although there are undoubtedly a number of noted makers who have endeavored, and that successfully, to bring the teachings of science to bear upon the composition and permanence of their products. A glance at any of the best books of reference shows, however, that the old empiricism and the modern exactitude are curiously blended together, and there is really no well defined line of procedure to guide the novice who ventures into the atramental region. It is, therefore, with pleasure that we give publicity to the following account of an important research on the subject by the well known pharmacist, Dr. William Inglis Clark. This research, we may say, was undertaken and completed when Dr. Clark was a laboratory assistant, and, under the title, "An Attempt to Place the Manufacture of Ink on a Scientific Basis," it was submitted to the Edinburgh University as a thesis for the degree of doctor of science. The thesis met with commendation from the university authorities, and, having served its purpose in securing him the degree, the writer did not think of publication; but, at our request, Dr. Clark has sent us the first part of the work.

Toward the beginning of this century a Dr. Lewis made some attempts to place the manufacture of ink on a satisfactory basis, and he succeeded so far as to determine that an excess of iron salt in the ink is detrimental to its permanence, such ink becoming brown on exposure. Three parts of galls to one part of ferrous sulphate were the proportions which he fixed upon as the best. He did not use boiling water in extracting the galls, and this has to be taken into account in considering exact experiments, for cold water would not, as he used it, extract more than half of the gallotannic acid from the galls. This observer was the first to introduce logwood as a tinctorial agent, and he made the interesting and important observation that acetic acid in the menstruum provides an ink of greater body and blackness than sulphuric acid does—a circumstance due to the smaller resistance of acetic acid to the formation of iron gallotannate. This observation has since been utilized by dyers. In 1798 Ribancourt determined that an excess of galls is quite as injurious to the permanence of ink as an excess of iron, but Dr. Clark's research does not sustain his explanation that this is due to the reducing action of the gallotannic acid. Dr. Bostock communicated a paper to the Society of Arts, in 1830, in the course of which he stated that the tannin, mucilage, and extractive matter are, "without doubt, the principal causes of the difficulty which is encountered in the formation of a perfect and durable ink. For a good ink the essential ingredients are gallic acid and a sesqui-salt of iron." In this point Dr. Bostock peculiarly hit the mark. Owing to his working with galls he was unable to make decisive experiments, but he concludes, and that rightly, that in proportion as ink consists merely of gallate of iron, it is less liable to decomposition and any kind of metamorphosis.

The introduction of blue black ink is the next phase of the development toward modern methods which is noticed. The object of adding a dye is to give temporary color to the ink, and, as indigo paste is used, it has been assumed that this keeps the iron gallotannate in solution. Any virtue of this kind which indigo paste possesses is more likely due to the sulphuric acid which it contains than to the indigo itself. The essential part of the paste required is the sulphindigotate of sodium, now commonly called indigo carmine. The commercial paste contains varying proportions of free sulphuric acid, and it is essential in ink manufacture that only the minimum of this constituent should be admitted. It is somewhat difficult to determine the proportion of acid present by the ordinary alkimetric methods, but by treating a known weight of the paste with excess of barium carbonate, and absorbing the evolved carbonic dioxide in a weighed potash bulb, the amount of sulphuric acid can be accurately obtained. Three samples of paste, which were found to be very suitable for ink making, gave the following figures:

Sample A, 0·45 per cent. CO_2=1·00 per cent. H_2SO_4.
Sample B, 0·319 per cent. CO_2=0·71 per cent. H_2SO_4.
Sample C, 0·235 per cent. CO_2=0·52 per cent. H_2SO_4.

The paste should not, therefore, contain more than 1 per cent. of H_2SO_4, and when it is remembered that as much as 50 per cent. has been found in commercial paste, the importance of watching this factor becomes apparent. An excess of acid in the ink corrodes pens, delays the darkening of writing, and sometimes perforates the paper. Apart from these objections it was

noticed in the course of the research that up to a certain point the addition of sulphuric acid was advantageous, and then just the opposite. This is shown by an experimental ink (0·536 gramme each of tannin and pure $FeSO_4$ in 50 c. c. of water plus the amount of acid indicated) in cylindrical jars:

Acid added $=CO_3$ Per cent.	Time exposed. Hours.	Weight of ppt. Grammes.	P. c. of Fe in ppt.
0·0	214	0·1043	8·3
0·01703	648	0·0923	8·66
0·03406	648	0·0403	10·42
0·05109	648	0·0198	8·53
0·06812	2,000	0·0000	0·00

The stability of an ink precipitate depends upon the amount of iron which it contains, and which on no account should be less than 8 per cent. More than the highest amount of acid above indicated throws down a white granular precipitate.

Similar experiments to the foregoing with gallic acid revealed the fact that no precipitate whatever is obtained under precisely similar conditions. This point followed up explained in a measure why a gall infusion prepared with hot water is not suitable for a blue black, while a cold water infusion is. In the latter case a comparatively small percentage of tannin is extracted from the galls, while much is extracted with hot water, and the consequence is that on adding the indigo blue the color of the latter is not brought out as it should be. Substantially the same thing occurs with ink made with the respective acids, although the blue color remains for a considerable time unimpaired in a tannin ink, and it appears to be due to the fact that ferrous tannate reduces indigo blue to indigo white, a change which the low reducing power of ferrous gallate does little to effect. The vegetable matter present in common inks facilitates the destruction, or, rather, alteration and precipitation of the indigo, for the dye appears in the iron precipitate and may be extracted from it with boiling water.

The investigation having demonstrated the superiority of tannin and gallic acid to galls, the opportunity was taken to determine the correct ratio of tannin and sulphate of iron to be used for ink. As in experiments previously mentioned, samples of ink were made containing different proportions of essential ingredients, exposed, and the percentage and nature of the precipitate determined. The results show that:

1. The amount of precipitate increases as the proportion of iron to tannin is increased.

2. The composition of the precipitate is so variable as to preclude the possibility of its being a definite body. Increase of iron in the solution has not at first any effect on the composition of the precipitate, but afterward iron is found in it in greater but not proportional amount.

3. At one point the proportions of iron in the precipitate and in solution are the same, and this is at between 6 and 10 parts of iron to 100 parts of tannin.

4. The proportion of iron in the precipitate varies with the length of time the ink has been exposed. At first the precipitate contains 10 per cent. of iron, but by and by a new one having only 7·5 per cent. is formed, and in from forty to seventy days we find one of 5·7 per cent., resembling $(C_{76}H_{52}HO_{46})_2Fe_2$. Simultaneously iron increases in the ink (proportionate to the tannin). These results differ markedly from those of Wittstein, recorded in Gmelin's "Chemistry."

5. These results show, and practice confirms, that 16 parts of iron (80 ferrous sulphate) and 100 parts of tannin are best for ink manufacture.

The research now traveled in a direction which accumulating experience showed to be obligatory. Blue black tannin ink lost color, and the reducing nature of the tannin tended to the formation of a highly objectionable precipitate in the ink, which made writing anything but a pleasure. These two faults were doubtless linked together in some way and seemed not to exist when gallic acid was used, for ink so made was found to precipitate only after a long exposure, it required no free acid to keep the precipitate in solution, retain the indigo blue color for a long time, alkalies did not decompose the ink, and provided blacker and more permanent writing. It is also notable that one of the most popular English blue black writing inks is a gallic acid ink. Determination of the correct proportions of gallic acid and ferrous sulphate to use was the subject of prolonged experiments, which were conducted on similar lines to those already detailed. The conclusions as to precipitation were also similar. Thirty parts of iron (150 of ferrous sulphate) and 100 parts of gallic acid were found to be the most suitable proportions for ink making. It is advisable, however, not to discard tannin altogether, owing to the slow blackening of the gallic acid ink, and a little tannin gives initial blackening and body, while it is absolutely necessary for copying ink. Initial blackness can also be insured by oxidizing 21 per cent. of the ferrous sulphate without adding the extra acid necessary to the formation of a ferric salt.

The concluding portion of the research was devoted to the influence of sugar upon the permanence of ink, and the results of the experiments are summed up in the following sentences:

"It would be injurious to add 3 per cent. of sugar to a tannin ink, while from 4 to 10 per cent. would be quite allowable. Most copying inks contain about 3·5 per cent. of sugar—not far from the critical amount. With gallic acid more than 3 per cent. of sugar hardly varies the precipitate, but the importance of this point is somewhat diminished by the fact that the presence of sugar is by no means necessary in a writing ink. Dextrin is a much superior substance to use. Curiously, this body rapidly precipitates a tannin ink; hence it is useless for copying ink, but for the gallic ink it is an excellent thickener."

While the thesis does not profess to exhaust the whole subject, it is apparent from the abstract that many points of difficulty are explained, and in the light of the knowledge thus recorded it is possible to carry on the manufacture of gall ink in a rational way.—Oil, Paint and Drug Reporter.

To Prevent Rusting of Surgical Instruments.—Common baking soda put into the water in which instruments are boiled in order to sterilize them will, to a great extent, if not totally, prevent rusting.—Medical Summary.

In 1895 a total of 3,434 vessels, with a tonnage of 8,448,383 tons, traversed the Suez Canal, paying tolls amounting to 75,934,357 francs. The toll for the 216,938 passengers produced 2,169,385 francs, and the accessory earnings 322,367 francs, making a total for transit of 78,426,110 francs. The number of vessels in 1895 that used the canal for the first time was 250. Three thousand two hundred and sixty-six vessels, or 95·1 per cent. of the total shipping, used the electric light, enabling them to continue their passage through the canal during the night. In 1894 the proportion was 94·9 per cent. The average time occupied by vessels in the canal during 1895 was 19 hours 18 minutes, and the average duration of steaming through the canal 16 hours 18 minutes. Compared with 1894, that represents a diminution of 37 minutes in the time occupied by vessels in the canal, and of 23 minutes in the actual steaming through it. In 1895 the number of vessels drawing over 7 m. of water that passed through the canal was 1,250, and among those vessels there were 228 that drew from 2 m. 51 cm. to 7 m. 80 cm., the maximum permitted by the regulations of navigation. The average tonnage of vessels using the canal increased from 2,398 tons in 1894 to 2,460 tons in 1895.

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